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Generating Engagement With Video Games Through Frustration And Hindrance

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GENERATING ENGAGEMENT WITH VIDEO GAMES THROUGH FRUSTRATION AND HINDRANCE

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Declaration of any previous submission of the work

The material presented here for examination for the award of a higher degree by research has / has not been incorporated into a submission for another degree.

Candidate's Signature

Declaration of authorship

I am the author of this thesis, and the work described therein was carried out by myself personally.

Candidate's Signature

Contents

1 Introduction

1.1 Frustration and Engagement of Video Gamers

The problems that can arise from excessive player frustration with video games are well reported[31, 28, 54, 105, 116, 23, 164, 113]. As the emerging literature surrounding video game frustration makes clear[102, 69, 26], the causes of that frustration can be complex and difficult to identify. In many cases however [69, 28], that literature shows the causes of frustration to include a players' inability to achieve in-game goals, and the results to include disengagement from the wider game rather than simply the specific obstacle to be overcome. In that context, it is perhaps unsurprising that the recognition and removal of frustration have been major focuses for the research community interested in the phenomenon.

Importantly, however, a game that creates no sense of frustration in its players risks becoming boring[102, 18, 69, 5, 41]. For example, a puzzle game in which every puzzle were instantly solved or an obstacle-driven game in which every obstacle were immediately surmounted is unlikely to attract or engage the players needed to make it profitable.

Comprehensive recognition and removal of all frustrating events or properties from a game may, therefore, come at the cost of removing players' engagement with that game – a substantial problem for developers trying to sell not only the game itself but, increasingly add-ons and upgrades to its player base e.g. the avatar costumes or 'skins' that underpin the commercial strategy[80, 133] of the popular game *Fortnite*: *Battle Royale*[67].

In that context, games developers (including, but not limited to those working at Paperseven, my host company for the Engineering Doctorate which underpins this thesis) need a wider understanding of the complex

relationship between frustration and engagement with the games that they produce. They cannot rely exclusively on an approach to frustration based upon its removal at all costs. They also need to be able to be able to understand when to include potentially frustrating elements in their games and how to design those elements such that they increase rather than harm player engagement.

1.2 Research Questions and Approach

In that context, extensions are needed to the 'identify and remove' approach to frustration, described in the scientific literature reviewed in Chapter 2. We need to complement the frameworks that describe the circumstances in which frustration acts as a deterrent to engagement with video games with models that predict the circumstances (if any), in which temporarily adding to or changing the nature of the frustration experienced by video gamers increases their engagement with and enjoyment of the games that they play. The term 'model' as used by this thesis refers to a predictive description of one variable's effect on another - i.e, introduction of a specific variable A will result in an increase or decline in a specific variable B.

In that context, the high-level research questions that guide the work in this thesis are:

- Can the generation of player frustration enhance a video game experience i.e. increase rather than decrease a player's engagement with that game?

- If so, when and how can this 'beneficial frustration' be achieved?

In the context of this work's focus on providing guidance to games designers and the second of the two research questions, above, I have adopted an

approach based on and read the literature described, below, through a lens of design science[165, 72, 123, 157, 99]. The literature review, which begins in chapter 2, outlines the basis for these research questions. The review does present a causal relationship between frustration and engagement: one where the presence of frustration results in a reduction in the latter. However discussions with games designers, including our colleagues at partner company Paperseven, suggested that this model could not account for the full range of impacts that they considered frustration to potentially have on player engagement.

The literature review develops the view that under the right conditions, frustration may have the opposing effect on engagement, where engagement increases with frustration instead of decreases. In the review, we outline how in-game frustration could potentially be able to generate aspects of gameplay that researchers agree are positive or that its absence may also harm engagement[69, 28]. Specifically, it was seen that challenge[18], pacing[47] and variety[17], each described by engagement researchers as positive aspects of a gameplay experience and a source of engagement, but may also be able to be created through the creation of frustration as well.

With this in mind, my research questions were driven by a desire to extend existing understanding of the impact of frustration on engagement. My subsequent work included both an exploratory study looking for examples of that extended impact and carefully controlled manipulations of gameplay in which I investigated candidate extensions to existing causal descriptions of frustration and engagement's relationship.

1.3 Definitions

Before starting to answer those high-level questions, however, it is important to note that researchers have proposed different understandings of the frustration that video gamers encounter when playing games, encountering obstacles and deciding whether to remain engaged with games, in which both occur. The detail of those different understandings is in part the subject of the literature review chapter, which follows this one. At this early stage, however, it is important to note that the Oxford English Dictionary (OED) provides two different starting points for understanding frustration[52]. The two definitions supplied by the OED are:

1. The prevention of the progress, success, or fulfilment of something.

2. The feeling of being upset or annoyed as a result of being unable to change or achieve something.

The first definition describes actions or states, which hinder or prevent progress towards a desired outcome. The second, describes the emotional outcome of that hindrance or prevention i.e. a user feeling upset or annoyed.

As Chapter 2 makes clear, researchers have been interested in each of these phenomena but have used the overloaded term 'frustration' to describe both. Yun, Ermi and Mäyrä and Canossa et al, describe frustration in terms of player emotion of annoyance after having progress impeded[167, 28, 60],while Gilleade and Dix, Juul, Allison and IJsselsteijn et al, on the other hand use definitions closer to the description of simply feeling they have been hindered[106, 69, 92, 84, 5]. 'Frustration' has therefore been used to describe both the feeling of or acknowledgement of being hindered, and emotion of annoyance or anger. In some cases, researchers appear to use both[41].

For the sake of clarity in this thesis, we will henceforth use the term **'Feeling of Hindrance'** (**FH**) when referring to the first definition (a feeling of prevention of progress) and **'Annoyance at Forestallment'** (**AF**) when referring to the second (the feeling of being upset or annoyed at having one's progress prevented). This in particular helps to avoid confusion as to whether we are referring to the feeling of having one's progress blocked, or the feeling of annoyance when one's progress is blocked. Such a distinction is additionally necessary because, as the literature review in chapter 2 also outlines, we felt there was a strong possibility that FH and AF may not always occur simultaneously and may instead represent different, if still connected, elements of the player's experience.

It is important to note that there is a difference between FH as described above, and game characteristics which empirically hinder the player. Again, these two phenomena need not always occur at the same time as one another. There is no guarantee that a player or participant in a game or study would report FH after encountering an empirical hindrance. For example, if a player dies and has to repeat a level, this can be considered an instance of empirical hindrance. However, we cannot say with complete certainty that a player will always report FH as a result. Even if the game is designed in such a way that the death and repeat of the level is *guaranteed* to occur, some still may not report FH. In the future chapters of this thesis I will introduce hindrances in games design, but will throughout all studies measure participant reports of experience of hindrance, in keeping with descriptions (albeit referred to as 'frustration' by the authors) by Gilleade and others[106, 69, 92, 84, 5].

Where the term **'frustration'** is used in this thesis, it refers only to the overloaded term used in previous literature, i.e. used to reference previous

literature but not to attempt to separate FH/AF as described above. Where the term **'hindrance'** is used in this thesis (i.e., injected hindrance, hindering events etc), it is in reference to the concept of in-game hindrances, i.e. obstacles or events in game which will or carry the potential to hinder the player's progress, possibly resulting in FH and AF.

1.4 Scope

The approach taken in this thesis to answering the research questions described in chapter 1.2 was to perform an exploratory study looking for examples of the relationship between frustration and engagement described by colleagues in the games industry and suggested to possibly exist in the literature review. After identifying such examples, the ongoing approach was to then pursue the causal explanations of the examples which were uncovered through performing further empirical studies.

Both subsequent conversations with game designers including colleagues at Paperseven, and other areas of literature covered in this thesis's literature review, suggested there may be additional causes of frustration's effect on engagement to be different to the most commonly described causal relationship (where increases in frustration result in decreases in engagement). These include narrative dissatisfaction[134][34], boredom [74], interruption[108] and lack of accessibility[138]. These factors remain potentially worthy of future investigation, however the work in this thesis focuses only on exploring causal explanations for the examples of positive frustration uncovered in the exploratory study.

1.5 Application to Games Design: Paperseven and Beyond

It is important to note that the work presented in this thesis was completed as part of an industry-based Doctor of Engineering course. The research described was supported in partnership with a games development company, Paperseven[104] a video games developer based in Brighton, UK. The studio's leadership have decades of combined industry experience. Paperseven believe increased understanding of FH and AF's effects on the player experience will enable them to make games which are better received and retain player interest for longer[19]. The studio also believes that a greater understanding of the impact of player FH and AF on engagement with their games will help them to make design decisions that other developers would not consider.

Ultimately, Paperseven believe that predictive models of the positive impact that FH and AF might have on player engagement with their games will set them apart from other development studios[20]. Paperseven have, therefore been extremely supportive of this work and have, as I will describe in Chapter 8, included discussion of its emerging conclusions in their development of new commercial titles.

1.6 Thesis Plan

The remaining chapters of this thesis report on work undertaken as part of an Engineering Doctorate with Paperseven's support. The structure of the work is reflected in the structure of the following chapters:

Chapter 2: Literature Review

In Chapter 2, we consider previous research, which provides insight into the two research questions, above. We note both the substantial body of research investigating engagement in video games and beyond[26, 88, 89, 140, 60] and the less extensively researched topics of frustration (both feeling of hindrance and annoyance at forestallment) in the same context[69, 90, 28, 167, 84, 121]. This Chapter identifies key themes in the frustration literature and notes the evidence that FH and AF can have negative effects on player engagement[36, 139, 143, 59]. It also lays out the need (introduced above) for extensions to existing research, investigating the potential for FH and AF to have positive effects on player engagement. Finally it defines a candidate new approach and extension to the literature in this chapter for looking at the relationship between FH, AF, and engagement. It draws upon the research which implies but does not explicitly investigate the possibility that some in-game events which result in FH (and subsequently AF) delivered with appropriate frequency and suitable variation in source may contribute to increases in player engagement. The Chapter concludes by noting that the utility or otherwise of these candidate extensions to the literature might be established through a body of empirical study.

Chapter 3: A New Approach

In Chapter 3, we identify candidate extensions to the literature introduced in Chapter 2, drawing upon insight into the literature, which may imply but does not explicitly investigate the possibility that some hindering events delivered with appropriate frequency and suitable variation in source may contribute to an increase in both FH and/or AF and player engagement with video games. This investigation forms the basis of our candidate causal

model of FH, AF and engagement. The chapter continues by noting that the utility or otherwise of these candidate extensions to the literature might be established through a body of empirical study.Subsequently, we detail our methodology and rationale for choosing it, and the extensive ethical considerations we made before performing this research.

Chapter 4: Study 1

In Chapter 4 we make a first contribution to that body of empirical work by reporting on an exploratory study undertaken with the aim of identifying circumstances, in which examples of feeling of hindrance and annoyance at forestallment lead to increased engagement with a widely discussed commercial video game. The game chosen as the basis for the study ('Limbo') was selected on the basis of reviews describing it as both frustrating and engaging[130]. The results of that study provide support for the idea that engagement can rise against a backdrop of mounting frustration. Subsequent analysis identifies a candidate explanation for those results; that the in-game hindering events observed took the form of gaps in the information provided to players and that overcoming this information deficit was engaging, while also driving increases in player FH. At the end of the chapter, we propose to investigate this candidate explanation further.

Chapter 5: Study 2,

In Chapter 5, we move from developing a candidate explanation of the phenomenon observed (increasing engagement in the context of increased hindering events) to testing it. The chapter reports on a between-subjects study, in which we propose variations of a simple puzzle game containing increasing hindrance injections caused by information deficits. Our working

hypothesis in this study is that the source of these hindrances injections (information deficits) will be engaging i.e. lead participants to report higher engagement with the conditions, in which information gaps are present than with those, in which they are not. Results provide no support for this hypothesis. The chapter continues with a discussion of the likelihood that this lack of support was caused either by the operational choices made in injecting hindrances or by flaws in the underlying model described in chapter 3. The conclusion is that sufficient evidence has been found to suggest support for the model that we should continue with our empirical investigations.

Chapter 6: Study 3

In Chapter 6, we return to the literature reviewed in Chapter 2 to identify the frequency ('pacing'), with which injected hindrance is encountered in video games as an independent variable that might be used to cause increases in the dependent variables of frustration and engagement. As a result of that review, this chapter proposes different versions of a new video game, each of which provides an injection of hindrance (and therefore creating FH and AF) events more frequently than the last. The hypothesis proposed is that the more rapid the delivery of manageable injected hindrances, the greater the challenge and, as consequence, the greater the engagement that will be reported by participants. Results of the resulting between subjects study do show circumstances in which this phenomenon can be observed but they also show that the effect (i.e. the high level of engagement) disappears quickly. The chapter concludes that further empirical work should be undertaken to consider other causes of 'beneficial frustration' that might cause longer lasting effects.

Chapter 7: Study 4

Chapter 7 reports on the final piece of empirical work undertaken as part of this Engineering Doctorate. It highlights a third potential source of engagement through injected hindrance – variation in the source or type of the injection. In this chapter, further versions are proposed of the game introduced in chapter 5 and a further between-subjects study is conducted to investigate the utility or otherwise of the variation proposed. The results show that engagement (along with FH and AF) is higher in the conditions in which the injected hindrances are varied than in those in which they are not. The chapter concludes with consideration of the potential implications of these results for games designers.

Chapter 8: Application to Games Design

Chapter 8 reports on the utility of the studies and findings, reported above to Paperseven. It describes the influence of this research on commercially available Paperseven games such as Beef the Bounty Hunter and Blackwood Crossing

The chapter also reports that the researcher undertaking this research was hired to a full-time role within the company as a Technical Designer, a role which allowed the ideas developed here to influence segments in the unreleased game The Other You, and in the recently released game Hot Wheels id (released in partnership with Mattel and Electric Square). Whilst this research and its findings will make contributions to researchers and practitioners beyond those at Paperseven, this chapter highlights the immediate and ongoing application of this work in the commercial sector.

Chapter 8: Discussion and Conclusions

Finally chapter 9 steps back from the work produced and its immediate application at Paperseven to reflect on the responses generated to the research questions above and the limits to the claims can be made as a result. Importantly, however, chapter 9 also identifies contributions to knowledge made as a result of this work and potential applications of those contributions to games development practitioners and the researchers from whose work we drew in earlier chapters. The chapter concludes by reporting on work which remains to be done to support comprehensive understanding of the complex interactions between hindrance, frustration and engagement.

2 Literature Review

We are not the first researchers to investigate frustration in video games or beyond. Others had already reported on the causes [8, 156], identification[167], measurement[43], impact[32]and mitigation[69] of each phenomenon. In that context, the next steps in this work were to review research that gave insight into the questions introduced in the previous chapter, to understand the extent to which that research provided a comprehensive response to our questions (or not) and to identify the extensions, if any that were needed to that literature if we were to deliver the predictive models of 'beneficial frustration' and its application.

2.1 Engagement

A recurring theme in the frustration literature covered in this literature review is the effect that player frustration has on player engagement. In particular, the most common relationship described is one in which frustration and engagements are opposites to one another. Where frustration grows, engagement is expected to fall. Where frustration falls, engagement is expected to increase. In order to understand what this stated relationship means for the player experience, and investigate the evidence supporting such a claim, we must first understand how engagement is described and calculated.

2.1.1 Definition and Description of Engagement

Engagement is described in a general context by the Cambridge Dictionary as 'the fact of being involved with something'. Several authors draw a direct link between engaging with a game and enjoying playing that game. Chen et

al reported that gamers who are engaged reported optimal enjoyment more frequently that unengaged participants[82]. Shastri et al demonstrated a close link between increases in enjoyment and increases in engagement when blending routine tasks with mental and physical challenges delivered via a game[141]. Allen et al reported upon introductions of gamified elements to writing practice and noted that game enjoyment was a strong predictor of game engagement[4].

Previous researchers in the gaming domain have identified different causes and characteristics of engagement. Most simply, Chanel et al describe engagement as being the opposite of boredom: if a player does not feel engaged by a game, they will instead feel bored[31]. Bouvier et al observed that while many descriptions of engagement exist, they are largely characteristic definitions of what players report or feel when engaged, rather than what engagement itself is. To that end, they describe engagement as 'the willingness to have emotions, affect and thoughts directed towards and aroused by the mediated activity in order to achieve a specific objective'. The objective in this case depends on the activity and the player's expectations, and engagement occurs when the expectations are met[22].

Brockmyer et al use engagement as a 'generic' indicator of game involvement, through the use of and measurement of immersion, presence, flow, psychological absorption and dissociation. The authors conceptualise moving through these experiences as representing a 'progression of ever-deeper engagement in game-playing'[25]. O'Brien and Toms report engagement as a positive quality reported by users of technology, primarily characterised by factors including but not limited to challenge, aesthetic appeal, interactivity and feedback, interest and motivation[119].

Most consistently, engagement is described as a key component of flow

and immersion (flow is a desirable state of complete immersion in an activity[114, 33, 42]). Brown and Cairns describe engagement as the lowest level of immersion before achieving engrossment and eventually total immersion - an engaged gamer is 'interested and wants to keep playing'. Ting-Jui and Chih-Chen described how games could lead to addiction for players, as it cultivates a wish to return to flow experiences players previously found positive[35].

Other researchers define engagement through its antonyms. Nacke and Lindley for example expressed that boredom is a counterpart to engagement, with engagement at a positive end of an experience scale and boredom at the other. Describing characteristics of a boring game, the authors express that opposite characteristics would lead to immersion and flow [116].

In this thesis, we intend to work within the definitions provided by other practitioners. We seek to challenge the established relationship between FH, AF and engagement from the side of FH and AF rather than the side of engagement. Our interactions with colleagues and investigation of literature have not provided reason to challenge the stated relationship from the side of engagement. Therefore we adopted a definition of engagement in keeping with Brockmyer et al, where engagement is a generic indicator of how involved a player is with a game, with enjoyment being strongly linked to engagement as discussed by Allen et al, Shastri et al and Chen et al.

2.1.2 Operationalisation of Engagement

Measurement of engagement is particularly relevant to the work in this thesis. Due to our primary focus of developing a better understanding of frustration's effect on players (as described in the studies covered in chapters 4 to 7 of this thesis), the close link between frustration and engagement ne-

cessitated we also measure engagement - or as described previously, FH, AF and Engagement. As an experiential phenomenon, engagement is impossible to measure exactly, and so previous researchers have taken different approaches to capturing and measuring reports of engagement. Like games for entertainment themselves, these approaches range from measuring proxies for engagement through the use of technology, to asking participants for direct reports of their engagement. Such approaches are important to review, as the studies carried out by this thesis aim to capture much of the same data, and we must identify ways to do so that are effective.

Some researchers have measured engagement through proxies for engagement: In 'Affective Gaming' for example, Sykes and Brown reported on how they were able to capture player arousal and involvement through a specialised gamepad which could detect the force the player used on a button. The greater the force used, the greater the emotional involvement of the player[147]. In a series of studies Canossa, Drachen et al used in-game metrics to capture player emotion through analysis of their in-game behaviour patterns, including player engagement and player frustration[28, 54, 55, 56]. In the latter such study, metrics were used to identify patterns of behaviour which were indicative of a total loss of engagement[28].

Yun utilised a thermal camera to monitor participant and player stress levels while playing a game, being able to detect through analysis of player stress levels when players were and were not enjoying themselves, toward a goal of games which can adjust their own gameplay in order to maintain user engagement[167]. Grafsgaard et al utilised an automated analysis of participant facial expressions, recorded using a specialised depth-camera and recognising subtle facial movements such as eyebrow raises, eyelid tightening and so on. Through these indications the authors highlight how facial

expressions can be positive predictors of engagement[71].

Other researchers have focused on asking participants to self-report their engagement. Direct questionnaires have been employed by practitioners to gather player emotion from study participants. Banyte and Gadeikiene made use of Brockmyer et al's Game Engagement Questionnaire[10, 25]. Brockmyer et al's questionnaire consists of a series of questions relating to the player's experience ranging from the player's reports of losing track of time, feeling wound up, or feeling different, categorised into absorption, flow and presence. Brockmyer et al's implementation of the questionnaire featured a 3-point response scale, responding to questions with answer of 'yes', 'no', and 'sort-of'. Banyte and Gadeikiene however successfully employed the GEQ utilising a 7-point likert scale instead, with responses ranging from a numbered value of 1 labelled 'totally disagree' to 7, labelled 'totally agree'.

Wiebe et al successfully measured participant engagement utilising a 'User Engagement Scale' and 'Flow State Scale', consisting of a 31 item and 36 item survey respectively, measured on a 5-point likert scale. The former focused on subscales relating to focused attention, felt involvement, novelty, endurability, aesthetics and perceived usability[161]. A similar 5-point scale approach was used by Jennet et al, which included direct questions relating to enjoyment and frustration[89]. Parnell et al validated a 'gameplay scale' across two studies, comprised of a questionnaire split across four subscales of affective experience, focus, playability barriers and usability barriers. Like Banyte and Gadeikiene, Parnell's questionnaire utilised a 7-point likert scale but across 49 questions, including directly asking participants if they enjoyed the game or had fun playing it. Parnell found that the scale could predict the appeal and quality of a game[122]. 7-point likert scales were also used successfully by Chanel[31]. This literature played a close role in developing

the approach to the studies in this thesis, showing that participants can be asked directly about their feelings of a game using likert-scale based questionnaires. The direct influence of this literature is discussed in further detail in the methodology described in the following chapter.

2.2 Frustration and Engagement Beyond Video Games

In domains beyond video games, researchers interested in frustration have concluded that both phenomena have negative impact on user experience of completing tasks. Hansen and Eddy[76], for example considered frustration in relation to student programming projects, noting that keeping a student engaged with the project will prevent them from becoming frustrated, with frustration an undesirable outcome. Grewe and Hualso[73] describe negative impacts of frustration in the domain of education, outlining methods for detecting when students are experiencing significant frustration levels, so that tips can be presented to reduce this frustration. Grafsgaard et al[71] utilised analysis of facial expressions to detect frustration in an education context and note that frustration prevents participants from learning.

Frustration is also a target in the domain of software usability research. For example Feild et al[64]consider the impacts of frustration when using web searches and link this with bad experiences even if they ultimately find what they were looking for. Bao et al[11]consider frustration and usability in operating system folder navigation, noting the undesirable frustration in difficulties locating the correct folder in a file structure and developing a system to assist users in order to minimise frustration. Weidemann and Russwinkel[160] note that even when dealing with 'psychologically perceived' frustration, there is a necessity to detect and minimise it in order to pursue outcomes for better human-machine interaction.

Jaksic et al[86] used AI agents to reduce user frustration by reading facial expressions during browsing. Klein et al[95] also discussed the negative impact of frustration, noting a necessity to help users recover from frustration instead of preventing it.

In the transport domain, Wilfinger et al[162] note that using transportation such as cars or public transportation can be frustrating due to crowding, delays and so on, and that frustration can lead to aggression or negative experiences from other users who are frustrated. Oehl et all [120]again discuss using AI assistants to reduce such frustration agreeing that frustration has negative effects on user experiences in driving, and results in reduced driving performance.

Meier and Elsweiler[109] consider the impact of frustration when browsing the internet. The authors discuss that troubles with re-finding information previously seen is a common user activity and can frustrate users, linking it with a generally negative experience. Also from the domain of web browsing, Lazar et al[101] discuss how frustration impacts blind web users, noting that it causes significant deterioration in their mode after experiencing frustration.

This literature played a key role in helping to begin formulating our research questions; they form the basis of the observation that frustration is typically thought of in a negative fashion. Even before we begin to examine literature which discusses frustration in games, a theme emerges where frustration is seen as a negative part of an interaction experience.

2.3 Frustration and Engagement In Video Games: Part 1 (Undesirable Effects)

In the narrower area of frustration only with video games, we found two overlapping bodies of research of relevance to this work. This first area, focused on the problems encountered by video game players, had player frustration (both feeling of hindrance and annoyance at forestallment) as a primary focus. The second area covered subsequently, focused on the investigation of *successful* video game design yielded additional understanding of FH and AF but did not focus primarily on those two phenomena.

2.3.1 Annoyance at Forestallment as a Cause of Disengagement

A recurring theme in the first area (research explicitly focused on frustration in video games), we found recurring reports of feeling of hindrance causing annoyance at forestallment, and AF subsequently causing loss of engagement.

IJsselsteijn et al, for example, make this link explicitly[84]. Cowley et al[40] and Engeser[59] make similar assertions. Johnson set al, Stråat et al, Chen and Halbhuber et al all also stress the negative effects of AF[91, 33, 74, 144].

Cox[41] also reports that frustration in general causes a loss of engagement particularly if perceived by players as the result of poor game design. Players will link the experience of frustration directly to badly-designed games.

Canossa et al[28] go further in identifying AF as the primary cause of players deciding to quit or give up on playing a game 'prematurely'.

Cheung[34] offers similar conclusions with specific reference to early game experience. Cheung investigated the ways in which designers held a player's

interest (engagement) in the first hour of playing a game. Cheung found that player engagement was dependent on both the difficulty of learning the mechanics of gameplay and the depth of the games' narrative. The study concluded that games should ensure neither can be fully absorbed in the first hour of gameplay. Cheung's study explicitly views AF as a 'negative experience' which must be minimised to avoid the risk of player disengagement [34].

Frustration is also seen in a negative light by Renshaw et al., who describe a balance between challenge and frustration, with the former a positive outcome and the latter a negative. Avoiding frustrating situations is described as a 'success'. In addition, frustration is also mentioned in the same contexts as boredom by the authors[129], further reinforcing that frustration is seen as unhelpful for delivering positive experiences.

Smeddinck et al note that frustration can work against positive game experiences, and note that developers might benefit from awareness of potential causes of frustration in their games as a result of how difficult they make the game[143].

AF has also been explored as a causal factor in the loss of player motivation in games, Lazarro explored the ways in which AF impacts upon player experience of video games in this manner. She describes situations in which players experience AF and, as a result lose motivation to play. Lazarro notes that 'fiero' can follow these feelings of AF (a feeling of pleasure or satisfaction at one's own accomplishments'), but also describes AF as a common cause of 'negative' emotion e.g. anger[102].

2.3.2 Feeling of Hindrance as a Cause of Annoyance at Forestallment

A second recurring theme in the research explicitly focused on frustration in video games is the assertion that feeling of hindrance and failure play key roles in the development of annoyance at forestallment.

Gilleade and Dix, for example, identify two key causes of FH; physical and mental failure.

- 'Physical Failure' is defined as a state, in which a player suffers from an inability to complete a command due to complexity or time restraints.
- The second indicator is 'mental failure'. Mental failure is defined as a state, in which the player is unable to complete a challenge, due to not knowing how to complete the challenge.

IJsselsteijn et al draw similar links between players failing to overcome challenges, and players who become frustrated (feeling FH) at a game. They also consider measurement of or detecting FH, identifying it as a phenomenon that occurs when a challenge becomes too great[84], i.e. when the player is unable to overcome a challenge. Ceaparu et al, Poels et al, Ford and Parnin, Mellecker and Vicencio-Moreira et al all discuss similar characteristics[30, 126, 110, 156].

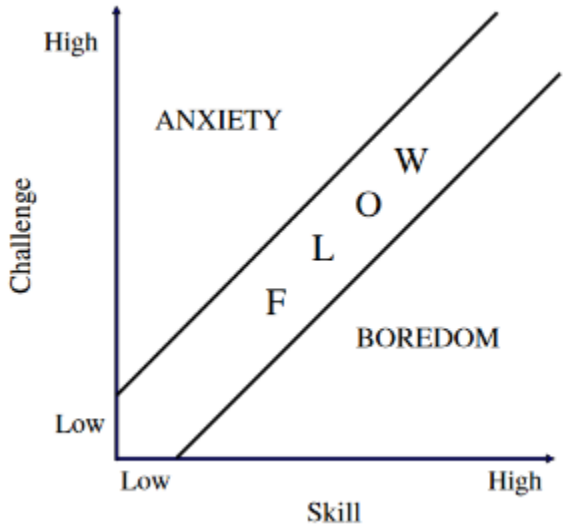
Cox goes further to describe FH as arising from challenges that players find difficult to overcome. The authors administered multiple experiments as part of a single study, the first of which increased the physical demands of a game, and the latter of which also made the game more cognitively challenging. In the first experiment, the authors describe situations in which FH arose from the need to play or think more quickly – a context, which reduces player ability to apply strategies. Some players also pointed out that

they did not have time to work out what to do in the game[41]. Klimmt adds that experiences of failure and arise more frequently under high difficulty conditions[97].

Canossa reports the failure to complete challenges regardless[28] of how it occurs, as a key factor in inducing player frustration. Breuer et al mirror this report, finding that anything which interferes with or which the player feels hindered can cause aversive emotions including AF, including when player skills lag behind the demands of the game[24]. Hartmann and Vorderer and Barlett and al also find that AF occurs as a result of failure to complete challenges.[77, 12].

The relationship between excessive challenge (which results in FH) and AF is also investigated by Csikszentmihalyi. Csikszentmihalyi described achieving a positive experience in tasks as coming from a balance between self perception of skill, and perception of difficulty[42]. This is easily expressed using a graph. Challenge rests on the y axis, with skill on the x axis (see figure 1). The most positive experience occurs when x and y values are roughly equal. Csikszentmihalyi describes the area where challenge exceeds skill as causing anxiety. This is analogous to FH and AF in games. Its presence outside the zone designated as flow implies it as a negative factor. Engeser applied this theory directly to games and found that the challenge-skill balance was partially supported in a study. The necessary balance described was moderated by the perceived importance of an activity and the user's motivation for achievement. When balanced challenges were present, the greatest levels of engagement were indeed observed[59]. However, this interpretation also positions FH and AF as an outcome of a failure to create a balanced gameplay experience. Similar views on the challenge skill balance are shared by Fong et al, Fullagar et al and Thin et

Figure 1: The traditional challenge-skill balance proposed by Csikzentmihalyi



al[65, 66, 148].

In summary, IJsselsteijn et al., Cox, Csikszentmihalyi and Canossa all draw direct causal links between feeling of hindrance, failure and annoyance at forestallment.

Building on this work Cowley et al propose a model of engagement and frustration where balance must be found between a game's external complexity and the player's internal understanding of the game. The game's external complexity is derived from the portion of the game's systems which are visible to the player through gameplay. The internal understanding is the player's understanding of those systems. Cowley proposes maintaining a gap between these two factors. This gap creates a cycle, in which the player continually needs to learn and adapt. This learning, once achieved allows them to overcome the game's challenges[40]. The gap described effectively creates a challenge, and is reminiscent of the Challenge-Skill balance suggested by Csikszentmihalyi or the loop described by IJsselsteijn. Too large

or too small a knowledge gap might not yield a satisfying challenge. As described by other studies, too small a gap (or too little challenge) will bore players, while too large a gap (or over challenging players) will cause FH and AF. Cowley et al themselves describe player reports of AF explicitly as a 'negative gaming experience' in the paper.

Cowley et al propose the removal of AF as useful tool that can be used to increase player engagement. Yun et al build upon this approach to propose removing both FH and AF from games outright[167]. Yun's work, like Cowley's suggests that removal of FH and AF will result in an improved gameplay experience.

2.3.3 Detecting and Removing Feeling of Hindrance and Annoyance at Forestallment

In response to the causal relationships asserted between feeling of hindrance, annoyance at forestallment and a loss of engagement, a third theme in this part of the literature is the detection of FH and AF as a step towards removing one or both.

Gilleade and Dix, for example, suggest that detecting player FH is an important step towards improving game design[69]. Their rationale for this suggestion is that by being able to detect player FH, they will be in a better position to remove it.

They build upon that suggestion to identify methods of capturing 'affect' from standard gaming input devices, allowing detection of FH without the use of new or specialised apparatus[69] (such as the stress detection cameras used in other studies[167]). Gilleade and Dix go on to propose that when FH is detected, a game may be able to automatically adjust its design in real time to mitigate this frustration.

Canossa et al propose blending quantitative and quantitative measures of detecting AF as a way to help designers to reduce or mitigate AF and build more enjoyable games. More specifically, they consider the use of in-game metrics to capture AF levels. They found these metrics to be effective in quantifying the player's AF. It was found that player's in-game behaviour will reflect their current level of AF[28].

Canossa et al link AF to 'bugs and balancing issues' in many cases, but also through the course of the study link factors such as 'player death events' to AF as well. Player death events occur when the player runs out of health and fails their objective - a form of failure.

Yun et al examined the use of stress monitors to detect player AF. The study was administrated by monitoring blood flow in certain vessels and muscles. This occurred as players moved from being a beginner, to intermedia through to expert. Difficulty was adjusted in line with experience to provide a good experience, following a pattern whereby detection of AF was taken as indicative of a negative player experience. As the players became more experienced with the game and its mechanics, the difficulty was adjusted upwards. Yun et al also demonstrate that the player experience can be positively influenced by detecting stress, thereby attempting to reduce AF by reducing the game's difficulty. Some success (improvement of player experience) was observed in doing so[167].

Drachen et al. focus on detection of AF with an emphasis on being able to minimise or remove it after automated detection[56, 55, 54]. Once again, this positions frustration as a phenomenon which is not part of the desired gameplay experience.

It should be noted that Drachen et also note differences between the player reactions to AF in different contexts. AF from sources such as bugs

or unfinished products produces different player behaviour to that arising from in-game experience, such as player character death. In each case, the authors report that they were able to identify specific patterns of behaviour connected to AF.

The common characteristics running through this growing research into video gamer frustration are that:

- FH and failure are key causes of frustration or AF
- The presence of AF leads directly to a negative experience for video gamers,
- FH and/or AF must, therefore, be mitigated or removed where detected.
- Mitigation or removal can be achieved automatically
  - i.e that control over AF is directly in the designer's hands
- Recurring focus on these undesirable characteristics of FH and AF go some way to explain the reason that much of the guidance given to games developers is that they should avoid FH and AF at all costs.
- That focus on negative outcomes provided little insight, however, into the two research questions identified in the last chapter (whether FH and AF had the potential to play a positive role in the development of player engagement and how games designers might take advantage of that potential if it existed).
- With that in mind we turned next to the literature describing the development of positive gaming experience in the hope of finding additional insight.

With respect to our research questions, this research reaffirms the themes that emerged in the non-gaming specific literature but now in the context of games. As well as being seen as overwhelmingly negative for general interaction experiences, it can be seen that frustration is predominantly considered to be negative for gaming experiences too, being described as something that reduces player engagement. The first of our research questions, 'can the generation of player frustration enhance a video game experience...' draws heavily from this literature: existing research would suggest most would disagree, with frustration presented as something to remove[53, 54], because it causes a feeling of hindrance[69] which creates AF which in turn leads to disengagement[167]. At the same time however, authors such as Lazarro do to some extent suggest a different relationship may exist[102] with engagement, but at certain moments rather than consistently. As well as the first question which is intended to question and allow us to test this interpretation of frustration's role in engagement, this was also an influence on the second question as well ('if so, when and how can this 'beneficial frustration' be achieved?'), suggesting and allowing us to test whether this effect (if it exists) occurs at all times or only in specific situations.

2.4 Hindrance and Frustration in Video Games Part 2: Desirable Effects

2.4.1 Introduction

The gaming engagement literature (described in this chapter) gave us a strong counterpoint to the AF/FH-focused literature introduced in the previous chapter. Where the AF/FH-focused literature had provided examples of risk and negative player reaction, engagement researchers provided us

with examples of game characteristics, reported to have caused strong engagement and positive player feedback.

This thesis focuses on uncovering if generation of FH and AF will always result in engagement loss, or if they can instead be retooled into concepts which can be deployed by designers to improve engagement. As we reviewed the engagement literature, we noted but did not pursue an interest in positively-received game characteristics which we did not think could be generated through the introduction of 'beneficial' FH and AF. In that context we noted the importance of subjects such as satisfying narrative structure [34, 134], connectivity to other players [127, 163]and aesthetic design[88, 122]. The remainder of this literature review focuses on descriptions of positively received game characteristics for which evidence suggests FH and AF may also be able to play a role in the development thereof. Though future work may reveal these features could play moderating roles in a causal relationship between FH, AF and engagement (see chapter 9.3), these characteristics were not a primary focus of this work, as further described by chapter 1.4 'scope'.

Key to this line of investigation was research by Ermi and Mäyrä, who present an understanding of frustration derived from models of immersion. The authors describe their work as a model of gameplay experience, though it does not propose the causal relationships between FH, AF and Engagement that companies such as Paperseven require in order to utilise frustration effectively. Rather, it identifies some key components relevant in the generation of immersion and engagement in players. The authors describe the gameplay experience as formed from three kinds of immersion. The first is sensory immersion, related to the game's audiovisual execution. The second is challenge based immersion. This is most powerful when there is a satisfy-

ing balance of challenge and ability. The last is imaginative immersion. This is when the player is allowed to use their imagination, or enjoy the game's world. Successful games are games that provide these types of immersion to players[60]. The authors acknowledge that playing a game does not always feel traditionally fun and can instead be stressful or frustrating and that in some contexts, experiences that are usually considered unpleasant (such as frustration) are experiences as pleasurable instead but do not directly consider if frustration itself can generate this immersion. The authors do refer to Klimmt however, who acknowledges that typically negative emotions can result in suspense, a positive emotion for players[96]. Neither article however directly describes frustration as a component of creating engaging gameplay, and this work is particularly focused on understanding frustration's effect on engagement. In order to help designers, we need to take a further step to draw out causal relationships between FH, AF and Engagement. Influenced by the observations about frustration in these articles, we examined known positive gameplay features that may also be possibly driven by commonly 'negative' emotions.

With this focus, we identified three characteristics of successful game design that could be achieved through the careful introduction of FH and/or AF.

2.4.2 Challenge

The first of these characteristics was the introduction of challenge to video games, a phenomenon generated by requiring players to overcome impediments to meeting their goals, for example Hudlicka and Van Den Hoogen et al[83, 81]. In other words, challenge requires the presence of hindrance and FH.

Hazlett et al considered challenge and its causes in their work. They describe the emotions developing throughout challenging gameplay, noting that when generating a challenge, negative emotions are typically followed by a positive emotional spike[78].

Bopp et al, whilst stopping short of asserting a causal link between hindrance and challenge, also noted that negative emotions can lead to positive experiences in games[18]. Brown[26] and Allison et al[5] also observe the phenomenon of negative emotions occurring in advance of engagement.

Additional evidence that impeding or hindering players may create engagement is provided by Lankveld et al[155]. Jennet et al take an even stronger view, holding that players may be challenged beyond their skill level but still find playing a game to be a 'satisfying and immersive experience'[89]. This observation is mirrored by Seah and Cairns[140], and also by Jin who notes that highly skilled players have more enjoyable experiences than less skilled players when encountering higher challenges[90]. Ashton et al note that Massively Multiplayer Online Role Playing Games (MMORPGs) often 'suffer' due to late game scenarios not being challenging enough for high skilled and experienced players[9].

The identification of challenge as an area which both a) requires feeling of hindrance to achieve and b) leads to engagement caused us to consider the possibility that embedding hindrances in a video game in order to cause FH and therefore challenge the players of that game might yield positive correlation between FH and engagement.

2.4.3 Variety

A parallel observation drawn from the engagement literature was the importance of variety to the generation of engagement (for example, Nacke

and Lindley, Fabricatore and Cheung[116, 61, 34]). This observation gave us cause to believe that we might also have identified a second area in which the introduction of hindering moments that cause FH and AF to games might lead to an increase in player engagement.

That importance is less widely researched than challenge but has been reported as a causal factor in the development of engagement. Kramer, Kultimat, Adams and Dormans and Schell all emphasise the importance of variety in gameplay[98, 100, 3, 138].

Furthermore Bond and Beale, for example, assert that variety is amongst the most important characteristics of high quality games[17], while Rauterberg [128] observes that without designed variety, users start to create it for themselves, subverting the intentions of designers.

Vallerand and Reid, Kensinger and Van Dijk and Kluger all note the potential to create variation by changing the information available to players.

Vallerand and Reid study the differing effects of positive and negative feedback on intrinsic motivation (motivation which is driven by internal rewards). The study found positive feedback created higher levels of intrinsic motivation. greater feelings of competence[152]. Positive feedback may serve as a way to improve feelings of competence even at times where the player may have instead experienced failure. If a player can feel competence even when they fail, they may enjoy the resulting frustration. Others such as Bressler et al and Baron have suggested similar outcomes as a result of how information is delivered[158, 13].

Desuvire and Wiberg[48] add that variation can be used as a useful heuristic in the assessment of player engagement with games.

It should be noted, however, that much of the literature that considers the importance of variety in video games also identifies a cognitive cost

associated with that variety. Researchers including Salvucci et al, Sanjram, Altmann et al, Richey et a, Yang et al, Czerwinski et al and Adamzyk[135, 137, 6, 131, 166, 44, 2] have all noted that the task switching associated with variation places cognitive burden on players and may overshadow the positive impact of the underlying variation.

The effects of positive and negative information were also examined by Kensinger et al. It was found that people have difficulty remembering specific details about positive information. Comparatively, they find it easy to recall details about negative information. In essence, negative experiences stick with users for longer[94]. Being able to learn from frustration was key to it being potentially enjoyable according to Nylund and Landfors[118]. Increasing challenge has been shown to increase both engagement and frustration, since frustration follows failed challenges and increased challenge increases likelihood of failure. This further suggests that using positive reinforcement after failure could ensure that players feel competence or enjoyment from that failure, since players can learn from it - the negative experience sticks around for longer.

Fabricatore notes that the use of 'core' and 'satellite' mechanics in games can allow a limited number of 'core' activities in a game to feel varied and create a feeling of novelty for players, however improper deployment of variety could instead significantly increase the complexity for players to an extent beyond their tastes[61].

Van Dijk and Kluger continued the theme of positive and negative information affecting reception of frustration. Van Dijk and Kluger extended this knowledge by outlining that the type of task undertaken also has an effect. When engaged with a creative task, positive feedback improved motivation and performance. In tasks requiring attention to detail, the op-

posite effects were seen[154]. This suggests the positive approach presented in the previous two studies may not always be appropriate, or the correct approach. There will be some situations where positive information delivery could provide better results, while there will be other times negative information works better instead. Determining whether a task requires attention to detail or creativity in a game could help designers shape information and feedback delivery to ensure players receive the right sort of information upon experiencing frustration to maximise potential positive outcomes.

2.4.4 Pacing

Pacing is a third characteristic of successful games that both contributes positively to engagement and can itself be generated through careful use of hindering moments in games that generate FH and AF. For example, Desuvire discussed that good gameplay requires pacing to apply pressure to the player, but not so much that the player becomes too frustrated[47].

The frequency with which FH or AF is introduced to a game will affect the speed with which players are forced to make decisions and act upon them (the pacing of the game in question). Varying the speeds with which decisions have to be made has been reported as a contributor to player engagement with video games.

Rauterberg ([128]) reports that in situations where no such variety is present, monotony can set in even if a task is initially enjoyable.

Milam et al[111] recommend consideration of a game's structure and the extent to which it pushes and pulls players through the game's levels and assert that these considerations will influence the engagement enjoyed by gamers.

Importantly for this work, however, carefully timed introductions and

removals of FH and AF can be used to create a sense of pacing. Pinelle for example et al applied heuristic evaluations to games and found that a game needs to avoid linear and monotonous pacing in order to engage players[124].

Feil and Scattergood[63] describe the use of in game hindrances in this way when introducing the concept of tension in pacing. They report that successful games design features a rhythm of rising and falling tension throughout levels. This tension draws the player through the game and its levels.

Przybylski also recognises the importance of good pacing, observing the ways in which early games increased the pace of challenges over time to keep players engaged[127]. Aponte et al note that precisely setting the pacing of a game's difficulty throughout a game's duration is also a crucial part of game design[8]. In a pair of studies, Sweetser notes that immersion is facilitated through feeling excited by a game's pacing with few periods of inactivity, and that gameplay should generally remain at a fast pace, without lengthy troughs[146, 145].

This work is extended by Milam et al who analysed 21 different games in order to identify the ways in which those games varied their pacing[111].

Davies examines how pacing affects gameplay, identifying four key aspects of using pacing successfully. These are Movement Impetus, Threat, Tension and Tempo[46]. Baumann et al found that pacing is the time pressure on players to make decisions, and the development of that time pressure. Different strategies of pacing can yield different player experiences[16].

The research relating to pacing, variety and challenge further contributed to the development of our research questions. Having established that the common way to think of frustration is as something which is not engaging, these topics further raise the possibility suggested initially by researchers such as Lazarro[102] that differing relationships may exist. The research

above suggests that FH and AF may be able to create or contribute to factors commonly seen as positive or engaging, further raising the relevance of questioning whether frustration is always the antithesis of engagement, or specifically, if it can contribute to engagement instead. Additionally, the research above refers to specific situations; rather than suggesting FH and AF may unilaterally contribute to positive changes in engagement, it suggests using it in certain ways or times may effect such a change. This helped fully crystallise the two research questions: first whether or not frustration can positively contribute to engagement, and second *when* it can happen, under the inference from research that frustration could contribute positively to engagement but is unlikely to do so at all times.

2.4.5 Conclusion

In conclusion, our review of previous research yielding insight into the impact that Feeling of Hindrance and Annoyance at Forestallment might have on the development of player engagement identified two separate but overlapping strands within that research. The first strand, which draws from and extends research with a wider interest in the effects of FH and AF on software users highlights the potential for FH to lead to AF and the subsequent potential for AF to result in disengagement from a game. Whilst we note the findings of that growing body of research, we have also learned from a second body of research, described in chapter 2.4, above, that key characteristics of successful, engaging video games can also be generated through carefully bounded use of FH and AF. We will next describe a new approach to understanding the effects of FH and AF, developed as a result of reviewing the literature introduced in chapter 2.4. In the chapters that follow, we will report on the empirical studies conducted in order to

investigate the utility or otherwise of that new approach.

3 A New Approach

In the previous chapter, we considered two approaches to increasing gamer engagement with video games.

The first starts from an understanding of failing engagement. That approach identifies Feeling of Hindrance and Annoyance at Forestallment as key contributors to lost engagement.[77, 12, 84, 41] and goes on to propose s upon software support for analysts and practitioners trying to mitigate each one.

The second approach starts from an understanding of successful engagement and focuses on characteristics of successful, engaging games design e.g. narrative[34, 134], aesthetic design[88, 122], connectivity to other players[127, 163], pacing [47, 111], and variety[118, 128].

Perhaps inevitably, the two approaches are not mutually exclusive. As we noted in the last chapter, the research community interested in the generation of challenge within video games explicitly notes the key role played in that area by the introduction of obstructions (in game hindrances) that hold players back from achieving their in-game goals. Overcoming those obstacles (which generate FH and AF) is reported to result in positive emotion and greater engagement with a game[102].

In other words, hindrances in games and the resulting FH and AF is a key contributor to the development of engagement – a more elegant description of the games design balancing act introduced at the start of this thesis.

Starting from that insight (that hindering moments of games were a key contributor to the development of FH and challenge), we then considered potential links to other games design characteristics identified as positive influences on player engagement. Within that part of the work, for example, we argued that FH and AF might play multiple useful roles in the

development of engaging variety in games.

The first application that we saw for FH and AF in the generation of variety arose from the deliberate use of FH and AF to create a sense of difference from surrounding accomplishment and satisfaction. If gamers had either just finished or were about to start a phase in a game likely to generate substantial satisfaction and a sense of achievement, we argued that an injection of FH and AF could be considered by games designers with a reduced risk of player disengagement. Simply put, we argued that designers could increase the difficulty of a game without diminishing player engagement by putting a hindering, FH/AF generating moment shortly before or after an in-game success.

The second application that we saw for FH in the generation of in-game variety was through the medium of challenge – if, as the challenge literature had implied, hindrances in games could be used to generate challenge then it was also a useful tool in the creation of challenge. Using in-game hindrances to create feelings of FH and AF, and challenge immediately after a relatively straightforward passage of gameplay or using a particularly obstructive FH/AF generating event to create more meaningful challenge for gamers who were racing through content could be a useful tool for designers seeking to vary player experience over time

The third application that we saw for FH and AF was as a design feature in itself – FH and AF generated in different ways, alternating between the mental and physical obstructions identified by Gilleade and Dix[69] and/or appearing at different points in time could all be used to create a sense of variation in gamer experience.

In discussion with Paperseven[19, 20], we realised that parallel arguments could be made around pacing – FH and AF could be introduced to create

contrast with surrounding passages of play, they could be used to create challenges with similar variations in frequency and/or used to create challenges to be presented with greater or smaller frequency through one scene, a phase of play or an entire game. In other words, pacing could be considered an example of variation that used time as the fluctuating variable.

With that in mind, we could now define multiple ways in which FH and AF could be used to generate phenomena that had been reported elsewhere (i.e. in the literature described in the previous chapter) as generating rather than diminishing engagement.

If the engagement of the challenge, variety and/or pacing generated though in game hindrances that result in FH exceeded the AF generated by blocking or impeding players' progress towards their own goals, then we could create situations in which in-game hindrances could be introduced to games whilst generating an effect that would have a net positive effect on the all-important phenomenon of player engagement.

In other words we had a candidate account of three ways in which we could use FH to increase rather than diminish player engagement:

- Use FH (through in game hindrances) to generate a feeling of challenge
- Use FH and/or AF to generate variety
- Use variety of in game hindrances which cause FH/AF to generate interesting pacing

If we limited the introduction of FH and AF to situations in which they served a higher (engaging) goal, we argued that we could make them positive design elements that games designers would look to use in a more principled manner rather than the undesirable problems described in the first sections of the previous chapter. This was our candidate model of frustration's effect

on engagement - introduction of frustrating gameplay features would result in increased engagement in players, provided that the frustration resulted in a feeling of variety, challenge or interesting pacing in players.

We next decided to investigate the utility or otherwise of this insight in authentic scenarios of use. More specifically, we conducted empirical studies in which we injected in game hindrances to generate FH/AF and therefore challenge, variety and pacing changes whilst measuring the impact of those interventions on player engagement.

In the following chapter of this thesis we will report on empirical studies conducted to investigate the utility or otherwise of this new, understanding of the relationship between FH, AF and engagement.

We will then consider the results of those studies in order to contribute to the understanding of feeling of hindrance and annoyance at forestallment and their potential use in games design settings. Such an understanding will make significant contributions to the existing body of literature which addresses the effect of FH/AF on engagement and enables researchers to contribute to the principled design of engaging, successful games.

3.1 Methodology

In the first chapter, we described the high level question which governed the research conducted in this thesis. We sought to question the common assertion among researchers that frustration was always a negative part of the gameplay experience, and that it would always result in a decrease in player engagement.

Through this question, we performed the literature review described in chapter 2. In that review we stepped through existing research into frustration and engagement in video games, demonstrating the dominant view

among researchers that frustration and engagement are always negatively correlated with one another (i.e. that frustration always causes a loss of engagement, and vice versa). Despite this the review also identified that in-game hindrances, typically seen as part of a relationship between engagement and frustration where these hindrances create feeling of hindrance, annoyance at forestallment, and finally a loss of engagement, could also contribute to generation of game characteristics described by researchers as engaging. We developed our two specific research questions in order to enable us to test if the stated relationship was consistently true:

- Can the generation of player frustration enhance a video game experience i.e. increase rather than decrease a player's engagement with that game?
- If so, when and how can this 'beneficial frustration' be achieved?

Instrumental in our motivation for formulating these questions was that colleagues within the games industry had asserted that they believed frustration could play a positive role in the development of player engagement. As described in the literature review however, we found no clear evidence that either FH or AF leading to increases in engagement in controlled conditions. Subsequently, we could not provide the guidance colleagues or other developers need on how to achieve this relationship. Furthermore, we did not find clear descriptions of the circumstances in which our colleague's assertions held, or causal descriptions of 'beneficial frustration' at the heart of those assertions.

Providing the guidance our colleagues were looking for would therefore require me to investigate:

1. The presence or otherwise of the positive frustration reported by games

developers and designers, and

2. Causal explanations of the ways in which positive frustration might be developed.

As a starting point for these investigations, we chose to consider passages of gameplay within a well known video games, reported to be both frustrating and engaging[130]. This approach led to the study reported in chapter 4. At that stage however I did not have sufficient information with which to evaluate the context and causes leading to positive frustration. With that in mind I decided to undertake an observational study where participants could report the circumstances in which increases in frustration (either FH or AF) occurred simultaneously with increases in engagement and to consider the contexts, if any, in which those simultaneous occurrences were reported. From this, we aimed to identify the elements of gameplay that surrounded these instances (if they existed) in order to develop hypotheses about the ways in which positive frustration had developed in an existing game.

In order to be able to identify the simultaneous occurrence of both FH, AF and engagement however, I needed a way to identify the moments at which participants experienced each one. In this area, I could draw upon work from practitioners and researchers who had previously developed approaches to identifying these phenomena in various circumstances.

Best practice within the games industry is to user test regularly - at set milestones on a project with external playtesters, and internally on a regular basis. Staff and members of the public who have signed non-disclosure agreements are asked to play through various segments of a still-in-development game at various points in the development cycle. Feedback is gathered from those playtests and collated to gain an understanding of what players think of the game so far, and from this action plans are created in order to address

specific concerns from players or improve the general impression.

To gather this data, the industry uses a mixture of open questions ('what was your favourite part of the segment you played? What did you not enjoy?' and so on), likert scale questions (participants respond on scale from 1 to a higher number, or nominative points on a scale in response to statements such as 'I found the balance of exploration to combat satisfying), metrics data analysis (through in-game event triggers and monitoring, we can for example track how long players spend in an area, how often they die, how often collectibles are found, and extrapolate conclusions from that data), and occasionally analysis of player physical reactions (when a player appears to be enjoying themselves, and so on).

These approaches do not however fully meet the needs for this thesis. These data collection methodologies are applied primarily to specific elements of a game, usually quite far into development. The outcomes of these playtests allow developers to react to player feelings, but they do not give them the predictive power they need in order to deliberately design games that are engaging. The way these techniques are applied is largely entirely about establishing player feelings rather than developing causal understanding of *why* players have those feelings. Additionally, these outcomes are usually based on wholesale design changes, rather than isolated variables with other surroundings remaining consistent. Developers test games as a whole, not isolated factors. Additionally the majority of internal testing conclusion are borne from a practitioner's subjective analysis of those results, rather than against a baseline established by research.

This works for industry and individual games design. The industry views asking players about how they felt about a game as a reliable source of data on player feelings. However, the majority of this approach does not help

develop a causal understanding for games as a whole.

As a second step towards an understanding of the causal relationship between FH, AF and engagement, and the ways in which both phenomena and relationship could be measured, we turned to previous research approaches, many of which are described in chapter 2's literature review. Some measured in-game behaviour patterns and isolated certain behaviours as indicative of different participant emotions[28, 54, 55, 56]. Others utilised technologically advanced methodologies of capturing participant emotion, such as thermal cameras[167], facial expression analysis[71] or pressure sensitive games controllers[147].

Most frequently however, similar methods are deployed by researchers as games industry practitioners, but with questions and analysis focused on uncovering relationships between specific variables and from a basis of empirical research over subjective analysis. Brockmyer[25] developed and used a questionnaire based approach called the 'Game Engagement Questionnaire', asking participants to respond 'yes', 'no' or 'sort of' to a series of questions about the game experience ('I lose track of time', 'my thoughts go fast' and so on). Similar questionnaire based methodologies are also used elsewhere. Most frequently, participants were asked to respond to statements relating to the player's experience on a likert scale from a 'strong disagree' to a 'strong agree', with either 5[161] or 7 points on the scale[10]. Though many questions relate to characteristics of engagement, a number of questions on these questionnaires directly ask participants if they felt annoyed, hindered or were enjoying themselves[122].

These approaches draw upon a wider more general literature and methodologies from affective computing, where systems are used to capture human emotion and reaction. For example, the facial expression analysis described

above is also used in affective computing. Many systems have been developed to automatically analyse spontaneous (that is, unplanned) facial expressions during various activities, such as Bartlett et al[14] and Cohn[38]. Analysis has also been applied to the difference between the aforementioned spontaneous expressions and deliberate expressions (i.e., a natural smile versus a forced smile)[153].

Also common is analysis of audible expressions by participants. By analysing the speech of participants, researchers can draw out information about the participant's emotional state. This includes Hirschberg et al, who used machine-learning techniques to ascertain when participants were being truthful or not in speech[79]. Zhang et al used an automatic speech recognition system to detect three different emotional classes of confidence, puzzle and hesitation in children during use of an intelligent tutoring system. Affective systems have also been used to detect specific audio patterns, such as laughter[150].

Additionally, researchers have utilised questionnaires and other methods for self-reporting affect. For example, Matthews et al utilised similar agree-disagree questionnaires to measure affect when driving[107]. Carnagey and Anderson, in addition to utilising a blood pressure cuff to monitor changes in affect, complemented their approach using a State Hostility Scale, answering questions such as 'I feel furious' on a 5-point likert scale when playing a video game described as violent[29]. In applications closer to gaming, Nacke described an approach of using psychometric questionnaires as a way to asses player emotion and cognition[115]. Russell et al created the 'Affect Grid', where after participating in an activity, participants are shown a 9-by-9 grid with labels at the corners and centre of each edge, with opposite corners and edges carrying opposite emotions ('stress' is opposite 'relaxation', 'pleasant

feelings' is opposite 'unpleasant feelings'). Participants report their feeling by placing a checkmark somewhere in the grid[132]. Colomo-Palacios et al also administered the Affect Grid to capture participant emotions when measuring affect in software requirements engineering[39].

Importantly, however, my work at Paperseven had highlighted the fact that video game players would often if not always report some level of both frustration and engagement throughout their interaction with any game. In that context, it was important to take a more granular approach to each phenomenon than simply to ask whether any level of FH, AF or engagement had been experienced.

Therefore, we followed the followed the approach used in a prominent and growing body of literature to explore the causal factors that underpin player engagement with games design. Specifically, we adopted an approach where participants are asked to play a game and are then asked to report on whether they felt hindered, frustrated or were enjoying themselves. For this self-report, we used the most commonly deployed approach of questions based on a 7-point likert scale, as they are easily understood by participants and provide continuous data making them suitable for qualitative statistical analysis. Additionally, likert scales enable us to capture more than just the simple existence of a phenomena, but also the extent of it and changes to it between scenarios and over time.

These questionnaires were deployed after a predefined gameplay segment by researchers, usually between different games. We also used predefined gameplay segments, but from within the same game with participants instructed after each segment to answer the questionnaire only for the segment they just played.

Enjoyment was chosen as a question over engagement due to its estab-

lishment as a characteristic with a strong direct link to engagement[82, 141, 4] and the precedent of participants being directly asked about enjoyment in other studies. We also deemed that enjoyment was more immediately understandable as a concept to participants than engagement. Measurements of FH, AF and engagement were chosen as the targets of the questions as in the literature examined in the previous chapter, these three phenomena were were constituent elements of the causal relationship between frustration and engagement by existing research (where FH leads to AF, which leads to a loss of engagement).

Mindful of the potential for frustration to be introduced to participants through interruption[1, 6, 44, 85], with participants aware that they would be playing through several scenarios in succession, we opted to minimise the potential for introduction of frustration other than that which the study game generated by reducing the questionnaire to only the direct questions about engagement, frustration and hindrance.

Following the conclusion of the first study, we had identified candidate examples of the under-researched relationship between FH, AF and engagement - see chapter 4.3 for details. However we had not yet identified a causal relationship between FH, AF and engagement. The examples identified could still have been situations in which FH, AF and engagement were not causally related or an example of correlation, or linked to other as-yet unidentified gameplay characteristics. With this in mind the approach taken by the subsequent empirical work was one of carefully controlled introduction of hindrances likely to result in FH/AF and subsequent measurement of player reports of FH, AF and engagement. That subsequent empirical work is reported upon in chapters 5 to 7. Importantly, this phase of the work also highlights the importance of the choice to differentiate between

in-game hindrances and participant reports of a feeling of hindrance that was described in chapter 1.3. That differentiation underpins the design of the studies reported in chapters 5 through 7, as those studies *introduce in-game hindrances*, but measure participant feeling of hindrance. Specifically we considered the extent to which gameplay elements intended to hinder player progression contributed to player reports of being hindered (FH) in different circumstances, and subsequently to reports of AF and/or engagement.

Importantly however, this differentiation notwithstanding we were able to continue to use the metrics developed for the study reported in chapter 4 to identify the different degrees of FH, AF and engagement reported by participants at key points in these studies, in addition to the approach of asking participants to play a carefully controlled game, stopping after various pre-chosen segments or intervals in order to ask participants about the different degrees of experienced hindrance, annoyance at forestallment and engagement reported through likert scales. The results of that subsequent empirical work is discussed in more detail in chapters 5 through 7.

3.2 Ethical Considerations

During the design of the studies reported in chapters 4 through 7 of this thesis, we took care to ensure ethical treatment of participants. In accordance with University of Bath Department of Computer Science protocols at the time of conducting this research, an ethical review was conducted according to the 13 point ethics checklist was completed prior to conducting each of the studies described in chapters 4 to 7 of this thesis. The questions in this checklist influenced the design of each study and the methodology of each study directly to ensure it was ethical. The 13 point checklist is comprised of 13 questions to which the design of any study or experiment

Figure 2: 13 Point Ethics Checklist/Questionnaire

1. Have you prepared a briefing script for volunteers?
2. Will the participants be using any non-standard hardware?
3. Is there any intentional deception of the participants?
4. How will participants voluntarily give consent?
5. Will the participants be exposed to any risks greater than those encountered in their normal work life?
6. Are you offering any incentive to the participants?
7. Are any of your participants under the age of 16?
8. Do any of your participants have an impairment that will limit their understanding or communication?
9. Are you in a position of authority or influence over any of your participants?
10. Will the participants be informed that they could withdraw at any time?
11. Will the participants be informed of your contact details?
12. Will participants be de-briefed?
13. Will the data collected from the participants be stored in an anonymous form?

must carefully consider before involving participants in research from which data is collected. Once a study's methodology had been designed under the influence of these questions, the design was then reviewed again and tested against the checklist. The questions guiding the checklist are shown in Figure 2.

The first study was an observational study undertaken in person with the researcher in the room with the participant at all times. Participants played a game using a laptop and a standard wired Xbox 360 game pad. After playing a segment of the game, a questionnaire was administered which

participants answered before starting the next game segment.

The study design was then reviewed according to the checklist described in Figure 2. A briefing script was prepared which was administered to all participants before they began study (shown in full in Appendix A). The briefing script covered the format of the study, including a preview of the questionnaire that would be shown to them. The briefing script also told participants how long the study would last, that data collection would be anonymous (point 13), and that there was an additional controls sheet they could reference if they forgot or needed to look up the game's controls while playing.

In addition, the briefing script included prompts as toward many of the other points on the checklist. This included notifying the participant that they could stop playing the study whenever they wish if they do not wish to continue (point 10 on the checklist), and also included a check of the participants consent after their briefing had been completed (point 4) with a separate form for them to sign before they began playing.

The hardware was judged to not be an ethical problem (per question 2 on the checklist), administered using the aforementioned laptop and gamepad. Both laptop and gamepad are common devices users would likely be familiar with. With respect to any intentional deception of the participants, there was judged to be none: we reviewed the entire content of the study against our briefing and were confident that our briefing script was exhaustive and did not hide any details from the participants. Additionally, we are not in a position of authority over participants as we are not involved in teaching or tutoring and so this was not a source of undue pressure to participate or answer in a certain way to participants (point 9).

The setting of a room on the university campus and use of standard

hardware meant there was no risk of participants being exposed to any risks greater than those encountered in normal office work life (point 5). In addition, the duration of the study was roughly one hour with frequent breaks from looking at the screen, meaning we were not exposing participants to excessive screen time without breaks. Engagement of only university students and staff helped ensure that no participants were under the age of 16 (point 7), though we also checked with participants beforehand. Participants were also asked to volunteer without any incentives offered, ensuring that there was no ethical risk with respect to inappropriate incentives or rewards (point 6).

Potential impairments that could limit understanding were considered (point 8), with one major potential issue. The game featured a large spider which chases the participant, which for those with a particular fear of spiders could be a source of stress or fear for them. In keeping with this, as well as the presence of the spider being mentioned in initial invitations to participate in the study, participants were also asked to confirm during the briefing that they did not suffer from arachnophobia. Participants were also asked to confirm they had not played the game before, as prior knowledge may be an unwanted influence on participant answers and may cause unreliable results.

Finally, participants were aware of our contact details, having been initially sourced via email and encouraged to contact us via the same details with any further questions or feedback (point 11), and participants were debriefed (point 12) with an explanation of both the study's purpose and how its design would fit in with the overall purpose of our research. The completed ethics checklist for this study is included in Appendix A.

The second, third and fourth studies were empirical studies in which participants once again played a game and answered questions at set intervals

throughout. However there were some key differences: participants would be playing remotely instead of in a room with the researcher present. Additionally, instead of playing a commercial game, participants would play games specifically created for the study. The use of a specially created game enabled us to modify the gameplay in order to attempt to induce certain emotional responses in groups of users (FH, AF, and engagement), instead of simply observing all participants playing one game. These methodological changes necessitated an additional thorough review under the terms of the 13 point ethics checklist.

Once again, despite the remote nature of the study, participants were given a briefing script. Instead of being given the game to play immediately, participants were instead sent a briefing script in a text file format. The briefing scripts covered many of the same points as the one used in the previous studies. The study format of playing a segment of the game before answering questions was explained, including the expected study duration, that the data collected would be anonymised and sent automatically on completion of the study. Again as with the previous study's briefing the questions the participants would be asked to answer were also included in the briefing document.

Also as before, the script reminded participants that they could quit the study at any time and it was explicitly noted that data was only captured if they completed the study. The script instructed participants to email a given address with an acknowledgement of their consent to the study before they began. The link to download the actual game used in the study was presented as the very last thing in the readme to ensure that the study briefing had been absorbed by participants. In the first study a controls printout was provided as a reminder of controls, while in this study the

controls were included in the readme as a reference. These briefing scripts are also included in Appendix A.

Despite the fact that the study was administered remotely without our presence, were were confident that there was no unusual or unethical hardware involved. The games built for these studies were all able to be played on a standard computer, laptop running either a windows, Linux or apple operating system. All studies supported mouse and keyboard as an input primarily, while one of the games also supported a controller as input if participants wished to use that instead. No non standard hardware was either required or supported.

The design of the games featured no intentional deception of participants. Studies 2 and 4 included simple puzzles to solve and the requirement to solve them to progress was stated explicitly to all participants. We closely considered the mechanics of the third study from an ethical perspective, to assess whether the design of the game amounted to a deliberate deception. We concluded that the game was not ethically problematic. Players were told to attempt to jump over gaps as they reached them, and that failing a jump would result in a minor time penalty. Players were not informed that some of the jumps would force them to fail, and other jumps would be impossible to fail in some circumstances. We chose the wording of the study description very carefully to ensure that were not deliberately misleading participants: participants were only told to *attempt* to jump over gaps, and it was never stated or implied that all or no gaps could be cleared successfully. It was demonstrably true that failing a jump would incur a time penalty, since where it was possible to do so, one would be incurred. Following this review, we were satisfied that we were able to maintain the integrity of the study with all participants trying to clear all jumps without

actually misleading any participants in the process.

All three interventional studies were not likely to result in any risks greater than those encountered in normal work life. As with the previous study, frequent breaks were built into the study, and the study durations were all shorter than the first study. The study only supported common, standard hardware, and so even if something non-standard was attempted to be used, they would not be able to participate using it. As before, no incentives were offered, and despite the remote nature of the study, only those we knew were over the age of 16 were invited to participate in the study.

No potential impairments were present for the third study, however special attention was paid to studies 2 and 4 with respect to this point on the checklist. The game used in the study featured colour-matching puzzles, and we identified that participants who suffered from colour blindness may not be able to complete the puzzles, or may struggle significantly moreso than other participants. To avoid any potential issues with this, we advised participants not to participate if they suffered from colour blindness.

Finally, participants would have been aware of our contact details due to the manner of invitation (email or messenger service), and the briefing script included our email address to contact with consent or other details. Participants were instructed in the briefing to confirm to the researchers that they were finished over the same medium they had previously communicated with us, so that we could respond with an explanation of the study's purpose and how it fits into our general research. The completed checklist for the design of these studies is also in Appendix A.

Some additional ethical concerns outside of the checklist were also considered. Though participants were over the age of 16, we also considered the

parental advice ratings for the game involved. The game, *Limbo*, featured a PEGI (Pan European Game Information) certification of 16, noting it as appropriate for audiences ages 16 and up. The games we developed for our own studies were carefully designed to avoid any scary or violent elements - only simple puzzles and visuals in each of the study games.

4 Study 1: Investigating the link between Feeling of Hindrance, Annoyance at Forestallment and Engagement

Note: This study is also presented in the peer reviewed conference paper "A Little Bit of Frustration Can Go a Long Way", published in ACG 2017: Advances in Computer Games[21].

The literature review in chapter 2 reported on a pair of different understandings of the way that frustration (FH and AF) could affect player experiences of gameplay. The first understanding was that FH and AF would damage player engagement wherever it occurred, while the second candidate understanding was that was that frustration, delivered through the right combination of pacing, variety and challenge could be a factor which creates engagement in games.

We also considered the implications of each of these different understandings for games designers, who aim to produce games which keep users engaged as long and as successfully as possible. The first understanding encourages developers to eliminate frustration in all cases, or in cases where this is not possible, minimisation of occurrence. Understanding of FH and AF as a causal factor in engagement however would allow its use more actively by designers, allowing increased engagement instead of only minimising damage. This approach requires extension of the current scientific literature on frustration in order to provide causal understandings of where, when and how designers might usefully employ deliberately frustrating game content. The final section of the literature review provided some initial direction on what these factors may be.

This chapter reports on a study which investigates the effects of such frustrating gameplay components on the engagement reported by players in a carefully controlled environment. This study represents the first step towards an extended understanding of frustration (FH and AF) and the impact it has on the player experience. More specifically it was designed to support identification of the absence of situations in which player engagement rose in spite of the presence of gameplay characteristics described as frustrating in prior research.

The following chapters report the results of carefully controlled interventions in player interaction with video games. In this study, however, we simply asked participants to player a popular video game which was also expected create FH and FH, and report on the experience of playing that game without altering the design of the game itself.

4.1 Study Design

4.1.1 Game Selection

In order to test those high level hypotheses, 17 participants were asked to play six phases from the middle of a commercial video game, 'Limbo' and to report the extent to which they felt that the game was hindering their progress, frustrating them and/or engaging them as they played. Limbo was chosen for several reasons:

Firstly, as a 2D game, it has a small and easily learned set of controls. It is therefore a game that can be easily learned in preparation. Participants should be able to quickly adapt to the controls. This removes the possibility acclimatisation periods affecting the results of the questionnaire. The game also features clear breaks between its challenges. These make for excellent natural rest points in which to ask users questions. Natural rest points were

noted as a way to minimise frustration from task changes in the literature review.

Secondly, a game was needed which had strong potential to be both highly engaging and generate large amount of FH and AF on an ongoing basis. Limbo has been noted for its difficult gameplay and challenging puzzles along with receiving strong review scores. It is, therefore a game, whose design has been noted in reviews as generating high levels of both frustration and engagement[130].

4.1.2 Aim

The aim of the study was to observe the extent to which frustration had a positive effect on participant engagement with a video game. At this early stage in our investigations, we did not make assumptions that participants would report frustration exclusively as an acknowledgement of failure in meeting in-game objectives (i.e. FH, the definition of utilised by several authors identified in the literature review, such as Gilleade and Dix[69]) or exclusively as an undesirable emotional state (i.e. AF, in line with the definition used in works by [167]). Our working assumption, which would be revised in light of the results, reported below, was that they were likely to report both simultaneously.

4.1.3 Hypotheses

Our high-level hypotheses were therefore

- That participants would report a positive correlation between the FH that they experienced and their engagement with the game
- That participants would also report a positive correlation between the AF that they experienced and their engagement with the game

4.1.4 Method

Design

In this exploratory phase of our work, we decided that the FH, AF and engagement recorded would be most useful as a basis for understanding player experience of commercial video games if we left the game selected in its original state. In that context, we did not intervene in the game nor did we ask groups of participants to report on different gameplay conditions. We asked all 17 participants to play the same phases of the game in the same order. We also asked them to report on identical parts of their experience on identical forms at identical points in the gameplay.

The gameplay portion of the study was broken into 6 sections or phases, with the study intended to last up to one hour. The first hour of the game was broken down based on pilot tests in order to determine where to place breakpoints to administer the questionnaire such that it fell roughly every 6-8 minutes. The first phase runs from the very beginning of the game where the player learns the game's controls through to avoiding a large boulder. The second phase runs from avoiding a pair of spike traps through to crossing a large body of water. The third phase involves the player attempting to get past a giant spider. and conclude following a chase sequence with a giant spider. The fourth phase sees the player attempt to escape from capture by the giant spider. The fifth phase has the player complete a challenging platform sequence, and the sixth phase involves escaping from the spider once more and finally killing it. Between each part the player was asked to pause the game to answer the questionnaire, before un-pausing it thereafter and continuing to play.

Players have only a small set of actions they can utilise in the game but

Figure 3: Jumping an obstacle.

which are used to complete a wide set of challenges. We felt this would ensure players were not overwhelmed by control options and would be able to focus on progressing through the study. These primary actions are:

- Jumping, to clear dangerous obstacles safely (figure 3).

- Climbing up certain objects (figure 4).

- Pushing and pulling objects to create platforms (figure 5).

Players use these basic actions in various combinations to overcome the game's platforming challenges and puzzles in various inventive ways. For example, one phase asks the player to pull a trap underneath a hanging vine with a weight attached to the end. The player then jumps to the vine and climbs it, causing the combined weight to drop the vine down into the trap, which dislodges the weight. This causes the vine to rise, giving the player enough height to reach a platform on the far side.

Figure 4: Climbing a rope.

Figure 5: Pulling a box to create a platform.

Materials

The study was administered using a laptop, with an Xbox 360 controller for control purposes. The laptop was powerful enough to run the game at 60 frames per second. It maintained this throughout the play session without introducing input lag in the game's controls. This ensured optimal playing conditions for participants.

Procedure

The study was undertaken in a controlled environment. Only the participant and researcher were present as each participant played the game

Participants were filtered by whether they had played the game in question before. Prior experience of the game might have an effect on how difficult the player finds the game. This would affect their responses. Further filtering was done to discourage participants who suffer from arachnophobia. The game features many sections where the player is chased by a large spider. In pilot runs of the study, participants who suffered from arachnophobia registered lower engagement scores in these segments. Choosing to omit these participants affords more consistent and reliable results.

Participants were given information about the study before starting to play the game. Each participant was told that they would be playing the game from the start, and that they would be asked to stop playing and answer questions at 6 points during the game. In each case they would be asked to answer questions only on the basis of their experience in the most recent period of gameplay i.e. they would be asked to report on their experience since the last pause point, rather than for a summary of their experience to date. These stopping points were roughly 10 minutes apart, placed between key gameplay set pieces so as to not interrupt users mid

Table 1: Questionnaire Questions

Number	Question Text	Answer Type
1	I am enjoying the game	7 point likert
2	I am finding the game frustrating	7 point likert
3	I felt the game actively hinders me from progressing	7 point likert

task. As described above, these were tweaked following pilot runs.

Participants were also briefed on the game's controls, and were given a printout for reference. The controls sheet also had a few basic tips for participants. For example that players would not need to backtrack to previous sections to make progress. Participants were informed that once the study began, they would not be able to receive help or advice in progressing through the game Each time the game stopped participants were asked to complete the Questionnaire (shown in Table 1, below) before continuing with the next section. Participants were informed they had a time limit of 10 minutes to complete each section. In the event that a participant ran over the allowed time for a section, they would be asked to pause the game and answer the questionnaire. Subsequently the game would be skipped ahead to the beginning of the next section.

The gameplay portion of the study was broken into 6 sections, with the intention of the study lasting up to an hour. This was felt to be a long enough period of gameplay to allow players to develop engagement and FH/AF. It also meant that the points at which they were asked to respond to the questionnaire would be far enough apart that responses could be considered descriptions of the most recent phase of gameplay rather than summaries of gameplay to date. Administering the questionnaire 6 times in roughly an hour was judged to be only a small interruption to the player.

We considered an approach to breaking the game up into phases on the basis of the number of obstacles that the player would have to overcome each section. Pilot runs showed that this led to substantially different amounts of time being taken to complete each phase – a factor that could have influenced the frustration and engagement scores reported. For example getting past the spider in phase 3 would technically count as a single obstacle, but this can take up to ten minutes for a player to figure out, while other tasks such as avoiding a rolling boulder in phase 1 can take under a minute. Under that initial design however these would have been treated equally.

It was also observed that obstacles encountered later in the game were more severe and required more skill and thought to overcome. This made them take longer. Ultimately, we adjusted the length of each phase to reflect the amount of time that pilot participants had taken to complete a section rather than the number of individual obstacles to be overcome.

Measurement

The order of the questions in the questionnaire was randomised for each participant. Participants were given time to familiarise themselves with the study questions in advance. This helped them answer the questions quickly in the study. In other words, we designed the process governing the questionnaire to avoid taking participants away from the game for too great a period.

At the six 'freeze points' in the study, participants used 7-point Likert scales to report on their own sense of FH, AF and engagement. The small number of questions ensured that the questionnaire could be answered quickly. This maximised time spent playing the game and minimised the time spent answering questions. The questions are shown in Table 1, above.

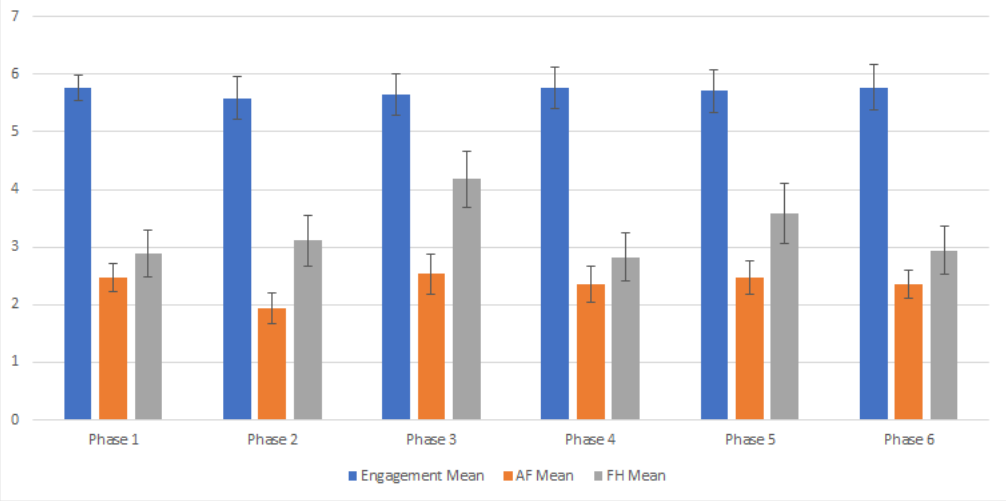
4.2 Results

Our results (found in full in Appendix B) confirmed our belief that the chosen game would be well received but provide sufficient FH that some level of AF would be observed. Table 2 shows the mean values for engagement (question 1), FH (question 2) and AF (question 3). Figure 6 shows a graph of the mean values per phase for engagement, AF and FH.

Table 2: Mean Engagement, Feeling of Hindrance and Annoyance at Forestallment

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	All
Engagement	5.765	5.588	5.647	5.765	5.706	5.765	5.706
FH	2.471	1.941	2.529	2.353	2.471	2.353	2.353
AF	2.882	3.118	4.176	2.824	3.588	2.941	3.255

Figure 6: Results for mean engagement, AF and FH per phase. Error bars represent standard error.



Overall, the mean engagement was 5.706 (standard deviation 1.460), whilst mean AF was 2.353 (standard deviation 1.211) and mean FH 3.255 (standard deviation 1.910), with occasional spikes to 6 or 7 for some individuals. A potential ceiling effect was observed for some participants; P5 and P7 recorded maximum scores for engagement throughout, and so care

should be taken with the interpretation of these results and in designing future studies.

Participants reported engagement alongside some degree of both FH and AF throughout their time playing the game. This aligned with our belief that games can simultaneously engage and hinder/annoy. We also found significant results supporting our second hypothesis, that participants also report a positive correlation between the AF that they experienced and their engagement with the game. A one sided Spearman ranked order test of the correlation between FH and engagement for all participants during Phase 3 showed that participants reported increasing engagement and an increasing sense of being hindered (see the jump in hindrance in phase 3 in table 2/figure 6) i.e. a positive correlation between FH and engagement ($rho = 0.522$, $p = 0.013$). This result indicates that FH can coincide with engagement.

Closer examination shows that many participants felt highly hindered during phase 3, with nine participants scoring a 5 or higher (P4-7, P10, P13-15, P17). Of these nine participants, all either maintained or increased their engagement during this phase. Two participants (P4, P5) are particularly interesting as they returned a (maximum) 7 score for engagement in spite of a FH increase from 3 to 7 in the same phase. Participant 10 also jumped from 2 to 6 FH while also maintaining engagement. Furthermore, participants 13 and 6 increased FH from below to above the midpoint (3 to 5). It is interesting that so many participants reported high levels of FH during phase 3 while their engagement did not suffer as a result. These results suggest that further investigation of game design choices during this phase would yield insight into the use of FH as a positive influence on participant experience.

What immediately stands out about the gameplay underpinning these

results is that Phase 3 contained only one, large, multi-faceted challenge (driving away a spider) rather than multiple smaller challenges (avoid the enemy, jump the gap). This presented players with a greater period of time, in which to experiment and learn. Game design in other phases provided multiple, smaller challenges, focusing on a single requirement per task. Instead of simply travelling left to right, this phase presents a more concrete goal to work toward. These differences in game design may explain the positive reaction (in terms of engagement) to high levels of FH - a possibility that can be explored in more detail in future work.

It is important to note that other examples of individual participants reporting high engagement whilst severely hindered in their progress towards in-game goals can be found beyond Phase 3. In Phase 5, for example, four participants (P5, P7, P8, P10) reported increases in FH yet did not report drops in engagement. Furthermore, P2 and P10 recorded an increase in frustration without loss of engagement in Phase 5. Phase 5 combines multiple small challenges which can be navigated quickly (for example determining how to avoid a swinging boulder) rather than a single challenge of long duration. The nature of this phase contrasts with that of Phase 3, which is made up of one, large, longer-lasting challenge. However, these smaller challenges combine multiple elements similar to Phase 3, but on a smaller scale. For example the player must first work out how to avoid a swinging boulder as they jump a gap, rather than only having to jump a gap as in other phases. As a result some participants may have found these challenges simultaneously hindering and engaging, as they did the larger ones in Phase 3 - a possibility we will also investigate further in future work.

In Phase 1, four participants (P8, P11, P12, P14) also reported noticeably higher scores for frustration than others before dropping in Phase 2 to

be more in line with other participants. These users' FH scores remained largely consistent between phase 1 and 2, as did their engagement. This unusual combination of frustration and engagement raises the possibility that users may have changing tolerance for frustration at different times (possibly being more forgiving at the start of the game). Their frustration may also have stemmed from unfamiliar controls and a need to acclimatise. These time based effects may be interesting for future study.

Elsewhere, several participants (P3-4, P9-10, P13) reported increases in frustration in phase 3 without a corresponding drop in engagement. Similarly four participants (P1, P3, P8, P12) showed a decrease in frustration between phase 1 and 2 without corresponding increases in their high levels of engagement. In these cases, we question the possibility that players who are already experiencing high levels of engagement may have a greater tolerance for increases in frustration, something we can test for in the future.

Each of these results contributes questions about our understanding of the relationship between feeling of hindrance, annoyance at forestallment and engagement in video games. More specifically, they challenge the uniform understanding of FH and AF as the antithesis of engagement and FH as the direct (and potentially only) cause of AF. Though this study was designed only to identify specific moments where AF, engagement and FH can behave in a manner opposing their expected relationships, we intend to investigate the extent to which these results are replicated in other games and whether a generalisable conclusion can be reached surrounding problem solving, FH and engagement.

4.3 Discussion

There are, of course, limits to the conclusions which can be drawn. This study considered only the feeling of hindrance, annoyance at forestallment, and engagement reported by 17 participants in a single game. It is not yet known whether these results can be generalised to describe other games both within and outside this genre. Additionally, while this initial study allowed observation of unexpected relationships between FH, AF and engagement, it stopped short of providing causal explanations for those results. Other studies are needed to develop these causal explanations. This study's results informed the approach in future work; for example the difficulty of analysing results in which participants rated their engagement with a game at the maximum score (the potential ceiling effect) was considered. One solution is to ask players how their feelings have changed from the previous phase rather than asking for a flat score repeatedly.

These results allow initial contributions to be made to the scientific discussion and understanding of frustration introduced in section 2 and feed back into the body of research from which the design of this study was drawn. The results provide some support for observations made in previous papers i.e. they provide evidence that engagement does often rise as FH and AF fall. Importantly, however, those results also provide evidence that FH and AF cannot simply be considered the antithesis of engagement and that the understanding of these constructs must be expanded. Primarily, they provide evidence that increased FH/AF is an outcome of increased engagement, and possibly necessary if we wish to engage players.

Participants reported a significant, positive correlation between rising feelings of hindrance (one of the two forms of frustration outlined in the introduction to this thesis) in their progress towards in-game goals and

rising engagement in Phase 3. Furthermore, when examining results on a participant-by-participant basis, other instances were found in which individual participants reported increasing engagement at the same time as rising AF and/or FH. These results demonstrate that FH and AF can have a positive as well as a negative impact on gamer engagement. Consideration of gameplay features in phases where these results occurred allowed development of candidate explanations of the ways in which a game's design could contribute to a more positive reception of FH and AF. Examples include giving players time and space to experiment and learn about a game during a hindrance, and the benefits of larger multi-faceted challenges over smaller sequential ones - areas which will be considered in future work. Further analysis of these features in the next section also outlines how they may be indicative of FH and/or AF being necessary for engagement. Addressing the FH or AF generated in this sequence would likely cause a loss of engagement factors.

Importantly, however, the results also highlighted the fact that greater understanding is needed about the individual differences that caused some but not all participants to report a positive correlation between FH and engagement. Additional understanding is also needed about the game design choices that caused hindrance of participants' progression towards their objectives to have a clear positive impact upon participant engagement in Phase 3 but not elsewhere. In this context, a further contribution of the work presented here is the identification of further research questions that can be fed back to the research community.

A second contribution is to the designers of games, both within Paperseven and beyond. The results emphasise the care that must be taken when creating FH and AF for players, since each one can lead to a drop in player

engagement. The results indicate that FH and AF is likely to occur when players are engaged, and that this should not necessarily be a cause for alarm. Those same results suggest that carefully designed FH and AF can be experienced as an engagement enhancing intervention. These findings support a more nuanced approach to the deliberate introduction of FH and AF than is implied by much of the previous literature.

This work also raises questions in areas outside of this research's specific focus. Researchers with an interest in gamification will ask whether FH/AF can also support engagement with serious games as well as entertaining ones. For the wider field of interaction research, it should be questioned whether frustration is always a negative outcome for interaction designs, or whether there are other areas, in which FH/AF can be harnessed as a positive influence on user experience. Just as the results reported here raise questions about the relationships between FH, AF and engagement in computer games, it is also important to consider the extent to which gamified smart meters, healthcare applications and training tools will also be less engaging if they never hinder or frustrate their users.

4.4 Conclusion and Next steps

In conclusion, the relationship between feeling of hindrance, annoyance at forestallment and engagement in one video game was been found to be more more varied than had been described by previous work. More specifically, examples of gameplay were identified that elicited a positive effect on player engagement as a result of hindering progression towards player goals. This effect was indicative of increased player FH being directly responsible for increased player engagement. Also found were multiple examples of individual players reporting that their sense of being hindered or feelings of AF

rose without causing engagement with the game that they were playing to fall. Additionally, it was found that some level of FH and AF was present throughout the gameplay experience. The implications were discussed of this work for the growing body of researchers with interests in the frustration caused by video games, for designers of those games and for a wider HCI community. Also discussed were limits to the claims that could be made as a result of this initial study.

The next steps for this work are to investigate the factors uncovered in the analysis of this study's results. Initial evidence suggests that following existing descriptions of ways to generate engagement in players will naturally create FH and/or AF. Instead of being bad for the experience, this is necessary for the game to be engaging. Future studies will aim to further assess this hypothesis. In particular, we develop the insight from this study by testing the various factors uncovered in a series of specifically designed studies. The literature review indicated that using FH/AF to engage players would only successfully result in engagement in the right circumstances (see chapter 2). Subsequent studies aimed to discern the effectiveness of strategies intended to create these circumstances. These strategies were based on observations in literature.

5 Study 2: Investigating Information, Feeling of Hindrance and Annoyance at Forestallment

The previous study reported on a study which investigated player responses to to passages of video game gameplay containing elements that generate feeling of hindrance and annoyance at forestallment. We identified a part of a popular, well received and publicly available game in which players reported both that they were being hindered while pursuing their in-game objectives, and that their engagement with the game was rising. This combination was evidence supporting the literature review's proposal of an understanding of FH/AF effect on the game experience that FH and/or AF could, in the right situations, be a causal factor of heightened game enjoyment; as opposed to traditional viewpoints positioning frustration and engagement as opposites to one another.

Importantly however, this research seeks not only to observe or describe a relation between FH/AF and the player experience where it is causal to a positive experience, but identification of a set of factors or methodology which can be exploited by game designers in order to enhance and maximise player enjoyment of games. The aim of this research is therefore to contribute to the scientific understanding of FH/AF's effects on players, and provide real guidance to designers.

In order to develop such a causal explanation and understanding, we undertook further studies beyond the first study which was purely observational. In these subsequent studies we made principled interventions in the player's game experience, guided significantly by the the literature examined in chapter 2's review, in order to investigate the extent to which

we could predict occurrences of FH/AF leading to rises in engagement or improvements in the general player experience.

This chapter reports on the first of these interventional studies. More specifically we report on a study where some groups of players of a specifically created game were deliberately introduced to events expected to hinder their gameplay experience. The frustrating elements were based on insight from the literature review relating to information use in games, due to the observation of player information deficiency playing a role in the successful segment of the previous study and the role of a knowledge gap in several influential engagement models, such as Cowley et al[40]. Introduction of these elements was expected to have varying impacts on the player's engagement and satisfaction with the game in the study.

5.1 Study Design

5.1.1 Game Design

A suitable game was needed in order to conduct this study. There were several characteristics that the chosen game would need to fulfil for a successful study:

- The chosen game needed to give direct control over availability of information. When new challenges are introduced, we needed to be able to control how much information each player received. This was a game with differing levels of information can be given to different groups of participants.

- In all aspects other than preparatory information and feedback, study cases should be identical.

- The chosen game would need to be accessible to a range of participants by being easy to pick up and play without an extensive learning period.
- The game should be easily deployable in a study environment.

We considered using a commercially available game in this study, as we had in the last e.g. 'The Witness', a game that challenged players to complete accessible and easily understood puzzles. We also considered using games developed at Paperseven, the games development partners in the Engineering Doctorate giving rise to this Thesis.

We were concerned, however, that using an existing game made the control of frustration more difficult since each game had already been designed to include multiple obstacles and challenges that the player would encounter and to build a narrative that linked each part of the game to the next. We were unsure that we could remove information from one part of the commercially available games considered, without having a knock on effect on player experience of other parts of those games.

We decided, therefore, to develop a game specifically for this study. This would guarantee a game which had the characteristics, introduced above; we could design it to be easily broken down into different repeatable configurations for study deployment, to be easily accessible to new players, to give us direct control over the level of information provided and, importantly, to keep the other aspects of the study functionally identical.

Most importantly, designing a game from scratch would allow us to vary the amount of preparatory information and feedback that would be provided to participants. Developing games from scratch is time consuming, however. To hasten the process the freely available Unity Engine was used to build the game with additional support from the visual scripting tool, Playmaker, while a simple world prototyping toolset, Probuilder, was used to construct

Figure 7: A clue for a puzzle.

the game environment. Using those tools, we developed a game which challenged participants to complete a series of puzzles within a simulated 3D environment.

Puzzles in the study were placed on panels throughout a specially made environment, and players needed to solve these puzzles sequentially in order to progress through the game. Each puzzle consists of two parts: a panel and a clue. The clue provided the preparatory information given to players i.e. it described a solution that would need to be reached. Feedback (information that showed the solution entered to be either correct or incorrect) was then provided once a solution had been proposed (see below). Figure 7, 8 and 9 provide an example of such a puzzle/clue pair.

On arrival at an individual puzzle, players were provided with grey-coloured buttons (see the figure 8). Players were then asked to use their mouse to click on the grey buttons. Pushing each button caused the button to cycle through a pre-set list of colours. The objective in each case was to keep pressing buttons until the colours on the panel matched those on the

Figure 8: The input panel for a puzzle. The lit square is the one the player currently has their mouse over.

Figure 9: The same puzzle in a partial completion state.

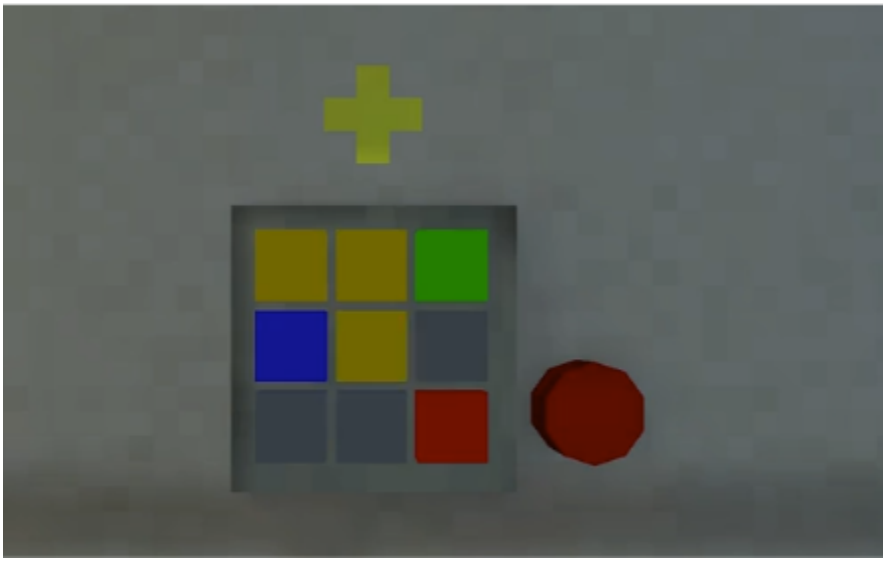
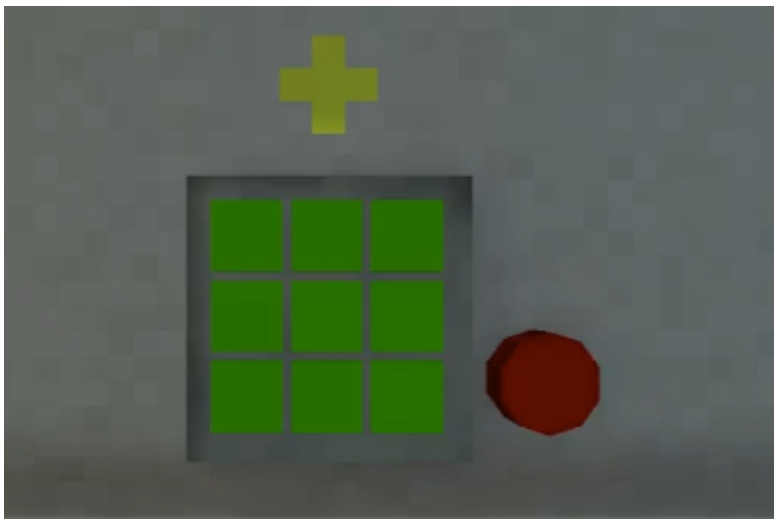


Figure 10: A solved puzzle flashing all tiles green.



clue (see figure 9). Once the player was convinced that a solution had been reached, they pressed a separate red button to indicate that they wanted feedback (this can be seen in figures 8 and 9).

If the puzzle had been completed successfully i.e. all colours matched those required a door opened in the environment and the player was able to progress to the next puzzle. If the player had provided an incorrect solution the buttons showing an incorrect colour were programmed to flash briefly in red, while those which were correct would flash green (see figure 10). This flashing was the primary source of feedback. Additionally, a negative bleep will sound if the player entered an incorrect solution.

5.1.2 Aim

The aim of the study was to investigate the extent to which the introduction of frustration i.e. the removal of preparatory information and/or feedback would provide interesting challenges to participants and, as a consequence, increase their engagement with the game that they had been asked to play.

5.1.3 Hypotheses

Our high level hypotheses were that:

- Players asked to play the game with both preparatory information and feedback would find the game least engaging
- Players asked to play the game without either preparatory information or feedback would find the game more engaging than those provided with both information sets
- Players provided with neither preparatory information nor feedback during gameplay would encounter the largest challenge and would, therefore, report the highest level of engagement with the game

The design of the game built for this study reflects the questions posed by these hypotheses.

5.1.4 Method

Design

Four versions of the game were created. Each version contained different combinations of preparatory information and feedback. Preparatory information was made up of:

- The clue panel.

Feedback was made up of:

- The confirmatory flashes of the puzzle buttons when pressing the solution button.
- The accompanying correct/incorrect sound.

In order to prevent the occurrence of learning between conditions, we designed a between subjects study, involving four conditions (one for each version of the game). Participants were asked to complete the game in one condition i.e. using one version of the game. Participants were randomly allocated to conditions. The four versions of the game were:

- Case A: A baseline version in which both preparatory information and feedback were present.
- Case B: A more frustrating version, in which feedback was provided but preparatory information was not
- Case C: A more frustrating version in which preparatory information was provided but feedback was not.
- Case D: A minimal information version in which neither preparatory information nor feedback were provided.

In order to prevent the occurrence of learning between conditions, we designed a between subjects study, involving four conditions (one for each version of the game). Participants were asked to complete the game in one condition i.e. using one version of the game. Participants were randomly allocated to conditions.

Armed with these different versions of the game, each designed to frustrate players to greater or lesser extent, we were able to finalise operational hypotheses as follows:

- H1: Participants in conditions B and C would report significantly higher levels of engagement than those in condition A
- H2: Participants in condition D would report significantly **lower** levels of engagement than those in conditions B and C

Materials

To gain a suitable number of participants for this study, the decision was taken to administer this study remotely. This allowed participants to complete the study without the need for our presence.

Participants

In total, this study had 44 participants, with 11 participants in each case. Since the study was delivered remotely, all instructions to participants were delivered both in game and prior to playing. Instead of directly sending players an exe file, participants were sent a readme file instead. This file had a link to the executable file at the end of the document, once players had read the instructions. Before the game begins, the player must read through these instructions again in-game. This ensures players are fully aware of the rules of the study.

Players were instructed to only play the game once, and asked not to quit the game mid play-through to prevent only receiving partial results. If a player played the game more than once, this would be apparent. The emails sent from the game contained metadata causing the email client to group emails from a single device together. Any playthroughs originating from the same device would therefore be discounted. Participants were vetted to ensure they could be trusted to only play through the game once.

Players were asked to only participate if they had access to a dedicated mouse, since the game required a lot of clicking and precise pointing. It was judged that a touchpad or other mouse might introduce unwanted additional frustration. Ensuring some consistency in hardware also helped to eliminate unwanted variation in results. This would have arisen from the difference in how difficult the game was to operate between different input methods.

Players were also asked to send a message to the administrator of the study after completing the study upon completion. This allows a double check that their results had been correctly emailed. Participants were asked not to delete the game's data folder until being instructed to do so. In cases that the email did not send correctly, players were asked to find a log text file. The log file contained the final results. Players were then asked to delete the game from their system.

Due to the colour-matching nature of the study, participants with colour-blindness were not included in the study. Pilot runs demonstrated that frustration from telling colours apart did add confounding frustration to the study.

Procedure

Participants were asked to undertake the study in private, in an environment where they would not be distracted by others and where others would not be able to provide input or advice.

Participants were given information about the study before starting to play the game. Participants were informed they would be playing a game which would stop automatically to ask them questions about their experience at regular intervals. They were told to keep playing until the study informed them it had completed, which would take roughly 25 minutes. A question interval duration of 2 minutes was chosen. Such an interval duration was deemed to be infrequent enough as to not be introducing frustration. This was because it would not stop gameplay too regularly relative to how long the questions took to answer. However it was frequent enough to capture how emotions evolved over the study's 20 minute duration. Every 2 minutes (not including time spent answering the questionnaire) the questionnaire would

Table 3: Questionnaire Questions

Number	Question Text	Answer Type
1	I am enjoying the game	7 point likert
2	I am finding the game frustrating	7 point likert
3	I felt the game actively hinders me from progressing	7 point likert

appear (the questions in the questionnaire are shown in Table 3, below).

Participants were briefed on the game's controls in a document supplied along side the game's executable file. Where appropriate, context sensitive prompts are displayed on screen, such as 'press E to interact'.

A play-through length of 20 minutes was targeted. The initial exploratory study was longer than this duration. However within a 20 minute period of that study there was significant variety of player frustration and engagement. It was thus determined that 20 minutes would be long enough for players to exhibit reactions to the changes present within each condition. This was also reflected in pilot tests of the study. It was, however, possible that a player should finish the study and have nothing left to do. This was because the study ended based on time elapsed and not on player progress through the game . The game was therefore designed so that it would take longer than 20 minutes to complete.

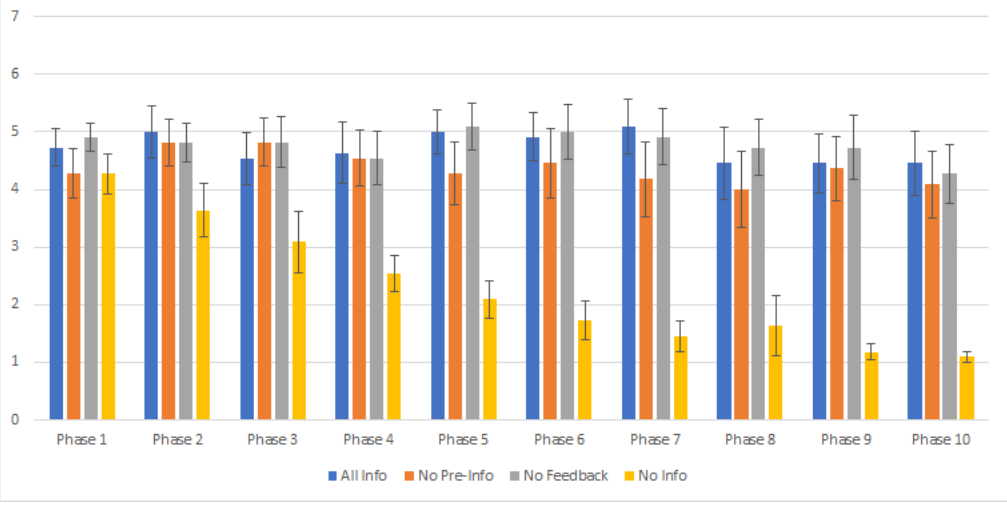
Owing to the volume of cases and required number of participants, a system was developed to allow remote play of the study. This allowed large numbers of players to participate more easily. A different executable file was produced for each version of the game, and participants were assigned a case executable at random. An email system was used to collect results. When the game itself stops every 2 minutes it, does not allow the player to continue until they have answered the questions presented. Upon answering all

questions, players can confirm their answers by pressing an on screen button. The button does not function if a question remains unanswered, making it impossible to continue without doing so. Once all are answered and submitted, the game continues and the timer resets. Once a total of 20 minutes has been played, the game collates the results, thanks the player and closes itself. This automatically sends an email to a dedicated inbox containing a string with the participant's responses. No additional personally identifying information was sent.

5.2 Results

The full results per measure in this study can be seen in Appendix B. The results confirmed that the introductions to gameplay we expected to be frustrating would induce greater feelings of FH and AF for players.Additionally, the results are visualised in figures 11, 12 13 and 14.

Figure 11: Results for mean engagement in all conditions, per phase
Error bars represent standard error.



Across all conditions, the mean engagement was 4.09 (standard deviation 1.473), while mean AF was 3.964 (standard deviation 1.666) and mean FH

Figure 12: Results for mean annoyance at forestallment in all conditions, per phase

Error bars represent standard error.

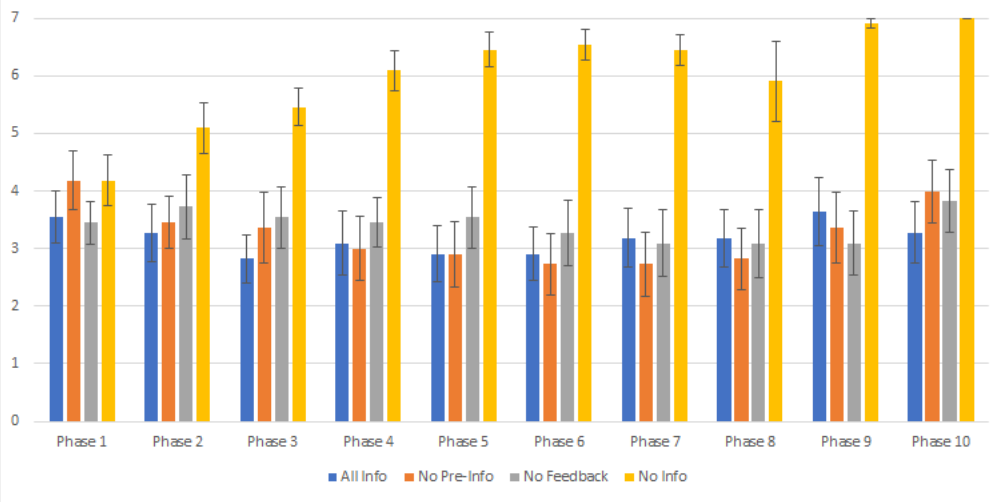


Figure 13: Results for mean feeling of hindrance in all conditions, per phase

Error bars represent standard error.

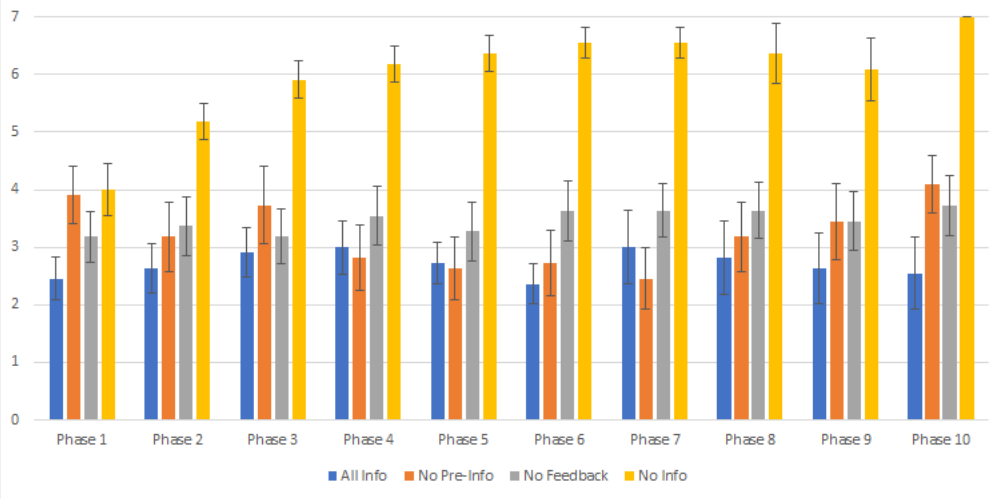
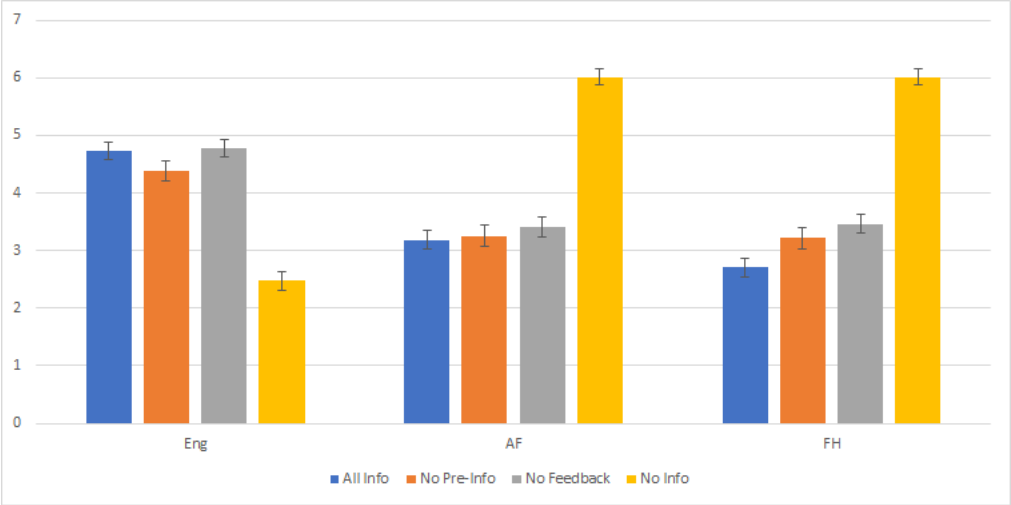


Figure 14: Results for mean overall engagement, annoyance at forestallment (AF) and feeling of hindrance (FH), per condition

Error bars represent standard error.



was 3.852 (standard deviation 1.821). As with the last study potential ceiling effects were observed in some participants, however these were mostly isolated to the fourth case (in which both preparatory information and feedback were reduced for players). Given that some changes made the game very difficult for players to make progress in, this was expected. In addition, figure 14 shows the overall mean engagement, AF and FH reported by participants for each condition.

Feeling of Hindrance

With respect to player reports of FH (one of the three variables we measured in the questionnaire), there were no unexpected reports for FH in any phase. As can be seen in figure 14, FH grew most severely in the condition where preparatory information and feedback were both reduced - note the large size of the 'no info' bar, but also note the size of the bars for 'no pre-info' and 'no feedback' relative to 'all info' as well. The condition featuring low information was significantly more hindering to players than the base

condition, as expected.

When we consider the collective results for FH, in a one tailed Mann-Whitney-Wilcoxon test between the base condition (which featured no reduction of available information) and the low information condition (which removed preparatory information), a significant difference in FH levels of $p = 0.0436$ was reported by participants. When contrasting the low feedback condition against the base condition, participants reported a significant difference of $p = 0.0003$. In both cases, this was an increase in FH. For low preparatory information, the mean FH was 3.218, while for low feedback the mean FH was 3.46. This is in contrast to the base condition which featured mean FH of 2.79.

These differences are seen also when comparing individual phases between cases. Phases 1 and 10 of the condition with reduced preparatory information reported increased FH, the former with $p = 0.0287$, and the latter with $p = 0.0384$. Elsewhere, in phase 6 of the condition with reduced feedback participants reported increased FH with a significance of $p = 0.0409$. These differences are reflected in figure 13 - note the relative difference between the 'all info' and 'no pre info' bars in phases 1 and 10, and the 'no info' and 'no feedback' bars in phase 6.

The most severe increases in FH were reported in the case which featured a reduction in both preparatory information and feedback. Note the consistently large gap between the bar for 'all info' and 'no info' in each part of the graph in figure 13. When contrasted against the base case, participants in this case reported a significant difference of $p < 0.001$. Again relative to the base condition's 2.79 mean FH, this condition reported 6.018 FH, the highest of all conditions. This same significant difference ($p < 0.001$) was also present when contrasting this condition against the conditions which

lowered preparatory information and feedback individually (again, note the gap between the 'no info' bar in figure 13 and the bars for the other conditions). This was again to be expected due to the removal of nearly all elements that would inform the player of what to do or how they were progressing.

This trend continued when contrasting individual gameplay phases. A significant increase in FH relative to the base case was reported in all phases, with $p = 0.0107$ in phase 1 and $p < 0.001$ in all phases thereafter. The condition was also significantly different in FH levels to the low preparatory information condition in 9 of 10 phases (e.g. $p = 0.0139$ in phase 3 and $p = 0.0001$ in phase 6) and to the low feedback condition in 9 of 10 cases (e.g. $p = 0.007$ in phase 2 and $p = 0.0005$ in phase 7).

Annoyance at Forestallment

With respect to player reports of AF (another of the three variables we measured in the questionnaire), there were again no unexpected reports for AF in any phase. As can be seen in figure 14, AF grew most severely in the condition where preparatory information and feedback were both reduced. When contrasting the condition which removed both preparatory information and feedback from the game against the base case, a significant increase in AF was reported by players, in both phase-to-phase comparisons and overall comparisons. A significant difference of $p < 0.0001$ was reported between this condition and the base case. Mean AF was 6.009 relative to the base case frustration mean of 3.182. Phase to phase resulted showed a significant increase in AF relative to the base condition in all phases except the first phase, with all phases reporting $p < 0.001$. Figure 12 shows the mean levels of AF reported by participants in each phase of the study, across

all conditions. Note how the bar for 'no info' in particular is higher than all other conditions throughout each phase. When contrasted against the condition which reduced only information or feedback, the condition again reported a significant increase in AF with $p < 0.001$ in both cases. These differences are not observed when contrasting the low information or low feedback conditions against the base condition.

Engagement

Continuing to engagement, as with the first study we conducted, AF and FH were a continuous presence in this study irrespective of the participant's engagement level. Though a minority of participants reported a floor effect in some cases (P4 and P6 in condition A, P19 in condition B and P30 in condition C), results consistently displayed that some degree of FH was continuously present for the vast majority of users. As can be seen in figure 14, engagement fell most severely in the condition where preparatory information and feedback were both reduced. Note the sharp decrease in engagement relative to 'all info' for 'no info'.

Even participants who reported the lowest possible FH at some points reported FH at other points, such as P5 in condition A, whose FH varied from highs of 4 to lows of 1, and P20 in condition B whose frustration varied from highs of 6 to lows of 1. The only condition with an appearance of consistently concurrent high FH and low engagement is condition D. Regardless, there are many cases where those reporting high levels of FH still reported high levels of engagement: for example P21 who reported FH of 5 in phase 6 still reported an engagement score of 5 at the same time. Observing these results shows that the level of FH felt may not be immediately tied to the level of engagement the player feels at all, since in phase 5 the

same participant reported another FH of 5 but only an engagement of 3.

We did not find significant evidence which directly suggests the addition of in game hindrances leads to additional engagement in players. Contrasting the conditions with reduced preparatory information and reduced feedback with the base case saw no significant reductions in engagement at the collective level (in figure 14, note the insignificant change in engagement levels from the 'all info' bar to the 'no info' and 'no feedback' bars. Contrasting the condition which reduced both manners of information resulted in a significant difference of $p < 0.0001$, with a mean engagement of 2.473, again relative to the base of 4.727. This same significant difference was also observed when contrasting this condition against the two conditions which reduced only one type of information (note the large relative differences in size of the 'no info' bar in figure 14 for engagement relative to the bars for the other conditions).

5.3 Discussion and Conclusion

In the context of the results described in the previous section, the goal of this study was to provide initial support for or challenges against the notion that we would be able to predict the impact of increased FH and AF on engagement, specifically that by introducing FH and AF to the player in a certain way (in game hindrance, through reducing the amount of information available to the player), we may be able to induce a positive change in the player's level of engagement relative to a condition where players have full access to information. In this study, we demonstrated that such an approach would not generally be effective.

However, in this attempt to identify if introducing FH and AF in this manner can lead to positive changes in engagement, we identified ways in

which we can continue to raise questions to feed back toward the literature from which we drew. Primarily, we saw that FH and engagement can exist in parallel with one another, rather than engagement existing only when FH or AF is low, and vice versa. Additionally, reports from participants in the most severe condition for FH and AF indicated that even in the most severe conditions, players can still experience reasonable levels of engagement, though such experiences do diminish quickly thereafter.

We found evidence supporting the viewpoint on FH/AF's effects on engagement expressed in chapter 2.3, specifically that FH/AF and engagement are opposites to one another. Both condition B and D reported significantly lower scores for engagement overall relative to a base condition with no alterations, while also reporting significantly higher scores for FH. In addition, AF was also significantly higher in condition D in addition to the higher reports of FH. This result first suggests that significant player FH is enough to impact the player experience in a negative direction. This suggests these two factors are not identical to one another. Furthermore, in the case of condition D, this can develop into a significant increase in AF. In both cases, player engagement is negatively affected by this change. These results support the suggestion that FH/AF and engagement are opposite factors.

We did not however find consistent evidence that FH and AF will influence player the player's level of engagement. Engagement was present throughout the study regardless of player levels of engagement, instead of appearing only when player engagement disappeared (as one would expect if engagement is the opposite of frustration). Therefore the correlation between FH and AF and engagement is not as clearly negative as some suggest it is. While this relationship *can* occur, it does not *always* occur.

There is no universal behaviour observed thus far which suggests that FH and/or AF's presence will always result in a loss of engagement. This leaves developers with further uncertainty about how to introduce frustration into their games if they believe it can be beneficial, given the result in the previous study which demonstrated FH can be beneficial to the player.

The study did not find support however for the further notion introduced in chapter 3 and observed in chapter 4's study that designers can introduce FH or AF deliberately as a way to create increased player engagement. It is unclear if this was a result of poor choice or design of characteristics that fit the hypotheses and goal introduced at the beginning of this chapter. For example, the hypotheses themselves may have been poorly constructed, or there are further empirical questions to explore in future work. We did find indications that led us to continue investigating the underlying hypothesis that beneficial frustration exists and can be created deliberately by designers. The consistent presence of player engagement even while reporting FH or AF suggested there is more depth to the relationship yet to uncover. In addition, players were for a short period engaged even in the most hindering and AF generating condition, even though this decayed rapidly in time.

There are some limitations to the conclusions which can be drawn from the present study. This study has investigated the factor of information removal as an in game hindrance in isolation. It is difficult to say for certain whether the removal of preparatory information and feedback will always behave in this manner in other genres of game. Further study will be needed in order to identify the effects these factors in other types of games. Though the study has confirmed that preparatory information and feedback can play influence player reception of FH and AF, they do not appear to be solely able to induce increased player engagement.

Therefore, despite these discoveries we are not at this stage able to extend existing causal descriptions of frustration's impact on player engagement, which suggest that frustration will be exclusively negative for the player's engagement levels. We must therefore consider the question of whether our understanding of a need for extending these causal descriptions was correct, or instead if our operational choices in this study were flawed. We cannot answer this question with immediate certainty without performing further investigative work. However, the discoveries discussed above (that frustration is continually present and can engagement be high even in conditions with high FH or AF though it rapidly degrades) give us cause to investigate extending existing causal descriptions further. Additionally, this study has at least demonstrated that the relationship between engagement and FH and AF is potentially more complex than considered in a significant volume of existing literature. With this in mind we chose to revisit the working understanding of FH/AF and engagement's relationship introduced at the beginning of this chapter and conducted further empirical work which allows to to consider support or otherwise for our revised beliefs. For example, there are further factors raised in the literature review and first study results that have not been explored, such as the roles of pacing and variety. These factors were kept consistent and without intervention in this study. This revision and subsequent investigation is described in the next chapter.

6 Study 3: Investigating Pacing and Frustration

In the previous chapter we reported on a study in which we investigated the idea that careful, principled embedding of elements within a game that generate feeling of hindrance or annoyance at forestallment could make positive contributions to player engagement within that game.

We found no support for the hypothesis that these events, which we had introduced, led to increased player engagement. This led us to question whether we were mistaken in our belief that 'beneficial frustration' could be identified in video games or whether the particular elements that we had chosen to embed within our first study were simply not those which would cause participant engagement to grow.

Phenomena identified during the study gave cause to continue unpacking the notion that 'beneficial' frustration might still be a useful concept to games designers. FH and AF were not found to be universally negative for the player experience, and negative results were inconsistent. While FH damaged the player experience in one case (condition B) it did not in another case (condition C), and AF itself was only an outcome in condition D. These results suggested there was more to uncover with respect to how FH and AF impact engagement.

In the context of those results, we returned to the literature introduced in chapter 2, and reconsidered our approach to developing frustrating elements of gameplay that we thought might cause engagement to rise.

More specifically, we looked beyond the literature identifying the lack of knowledge as a key challenge that might motivate players to consider the pace at which we inserted events that cause FH and/or AF within a

game. That review caused us to consider the extent to which suitably pacing would lead players to enjoy the challenges associated with our inserted FH or AF generating events, whilst poor pacing, and specifically the provision of multiple instances of FH or AF within a short space of time, would cause a parallel drop in engagement. In developing this idea, we drew on the notion of 'push and pull' pacing introduced in chapter 2 and proposed by authors such as Milam et al.

In order to investigate the impact of pacing on the impact of FH and AF, we developed a further study, in which participants were asked to complete a 3D platform game of our own design whilst encountering guaranteed progress hindering events scheduled to arrive in quick succession in one condition (rapid pacing) and infrequently in another.

We maintained our view that players encountering no hindering events at all would be the least engaged with our game but that, amongst those to whom we did introduce gameplay elements that would generate FH/AF, those whose instances of FH/AF were less frequent would be more engaged than those hindered repeatedly within a short period of time.

6.1 Game Design

6.1.1 Overview

A suitable game was again needed to provide the environment in which we would inject and measure the effects of hindering events. As was the case in Study 2, we identified the key characteristics of the game chosen as follows:

- The game chosen needed to give complete and direct control over the injected hindrances. We needed to be able to create multiple configurations of the game. In each configuration, hindrance injections needed

to occur with a chosen regularity.

- Players should not be able to use luck or skill to overcome the moments where FH/AF is intended to be generated. This should not, however, be visible to the player.
- In all aspects other than the injected hindrances, each version of the game must be identical to the others
- The chosen game would need to be accessible to a range of participants by being easy to pick up and play without an extensive learning period
- The game should be easily deployable in a study environment

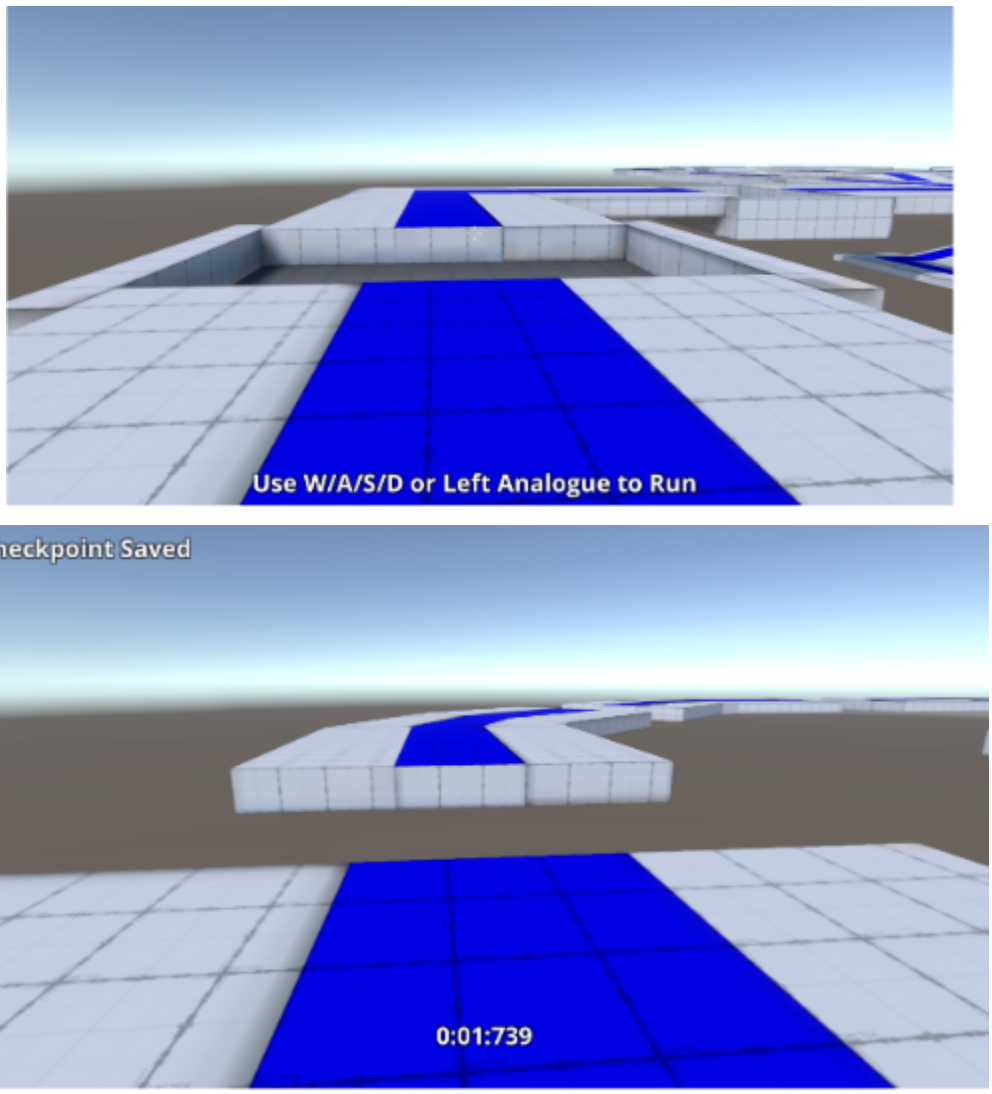
An early design decision when choosing a specific game with each of the characteristics, above was that a platform-based game i.e. a game in which a player-controlled avatar would run along a platform and jump over obstacles/over gaps would be a suitable choice.

The introduction of FH/AF into a platform game is relatively straightforward. We can create gaps in platforms the player must jump across. If the gap is large, players are unlikely to be able to cause their avatar to jump across the gap resulting in player failure (a characteristic that Gilleade and Dix, Canossa and Drachen report as frustrating in section 2.2), therefore generating FH/AF.

Despite the choice of gaming genre, however, no commercially available game was identified that embodied each of the characteristics, listed above.

We found games that allowed for editing of levels and were easily deployable in a study environment (e.g. Super Mario Maker). Those games and their editing environments did not, however provide sufficient control to allow us to introduce unavoidable hindrances and therefore FH/AF at key points in the gameplay or to remove FH/AF when it occurred elsewhere.

Figure 15: The introductory area (image 1) and subsequent area (image 2) in the platform game study.



Since no suitable existing game was found, we decided, again, to develop a game specifically for the purposes of the study. As with the puzzle game that we had created for the study described in the previous chapter, the game was built using the Unity engine. Screenshots of the game that we designed are provided in Figure 15, below

6.1.2 Adding Feeling of Hindrance and Annoyance at Forestallment

Our next considerations were the mechanisms through which we would impose FH/AF generating events when study conditions demanded and remove them when they did not.

Creating a hindrance that is a difficult challenge that the player was unlikely to overcome would have been relatively easy. Our objectives for this study meant, however, that we needed to know with some certainty whether participants would be hindered in the pursuit of in game goals or not. An extremely difficult challenge that was nonetheless possible did not provide this level of certainty.

In the context of having chosen a simple platform game i.e. a game in which players would be asked to move an avatar along a scrolling 'platform' and to jump across gaps in that platform at regular intervals, we decided to vary the extent to which we hindered participants in the jumping task. More specifically, we decided to make some jumps impossible to achieve and others impossible not to achieve. We wanted to implement these guaranteed successes and failures in a way that was not easy for the players to notice. The hindrances that are impossible to avoid would be guaranteed to generate FH/AF, while the ones which are impossible not to avoid would not generate FH/AF.

Our first attempt at imposing guaranteed success and failure on players of our newly designed game was to adjust the physics imposed by the Unity game engine at key points in the game.

The Unity engine allows adjustment of the effect that gravity has on the player, the force they jump with, their movement speed and air control. A base set of values for each of these variables was created. I then used

in-engine tools to calculate the exact maximum possible distance that the player was able to jump using these physics values. At the points the player needed to experience a failure, the values were modified to ensure that the jump required was impossible.

Whilst pilot testing this approach, it became clear that this approach had been noticed by participants.

We dealt with this by reverting to a constant set of physical rules and setting all jumps to a distance that players were unable to complete i.e. to make the gaps between one part of the platform and the next too wide to be jumped over. The width of gap between platforms was, however, left narrow enough to look possible. Further pilot testing showed this to be less easy for participants to notice than changing the ways in which avatars moved To be extra certain, invisible colliders were added on the landing side of each gap, effectively behaving like an invisible wall. These brought the game to state in which players would be asked to jump over a sequence of impossibly wide gaps.

6.1.3 Reducing Feeling of Hindrance and Annoyance at Forestallment

Having made every jump in our game impossible to achieve, our next task was to identify a mechanism that could be used to ensure successful jumping where required. Combinations of impossible jumps and jumps that would always be achieved would allow us to vary the frequency of success and failure in each condition of our study – a key tool in our desire to regulate the frequency with which frustration occurred ('pacing').

In parallel to our work creating 'impossible' jumps (described above) we tried different ways to create guaranteed success that would not be obvious

to participants in our study.

Once again, we tested different settings within the settings of the physics engine governing the game, making players lighter and stronger in attempts to guarantee jumping success when required. Once again, however, pilot testing showed this approach to be too obvious to players.

Other designs were then considered. One approach was the use of 'context sensitive' jumping, which meant that pressing the jump button too far from a gap was ignored and that reaching the edge of a jump caused the players avatar to be frozen and a prompt to appear calling for a jump to be attempted. This approach was rejected because it created too obvious a divide between forced failure and forced success. If the prompt only appeared for some jumps it would be obvious which ones are successful, or players may think it was a bug that the prompt did not appear. If the prompt always appeared but sometimes the player fell anyway, they may also blame the failure on a bug.

Finally, we added invisible flooring tiles to both the start and the end of jumps. If a player jumped either too early or too late, these invisible flooring tiles would ensure that they would still complete the jump successfully. As an additional safety net, an invisible trigger was added at the start of each jump. This trigger would cause the player to automatically jump if they had not already done so. The combination of forced jumping and invisible flooring aids meant that players were guaranteed to complete jumps with these features in place.

Pilot testing confirmed both that players successfully cleared these jumps every time and, for the short period of gameplay that we asked them to complete, that they were unaware that success or failure was guaranteed for each jump.

6.1.4 Game Variations

We built four versions of the game, designed to force players to experience different combinations of successful and unsuccessful gameplay:

1. In the first version, every jump was guaranteed to be successful. Each time a gap occurred, the participant was helped to get over it, as described above (0% injected hindrance).

2. In the second version, participants were forced to fall into one gap in three (33% injected hindrance).

3. In the third version, participants were forced to fall into two gaps in three (66% injected hindrance).

4. In the fourth version, participants were forced to fall into every gap (100% injected hindrance).

6.2 Study Design

6.2.1 Aim

The aim of the study was to investigate the extent to which the frequency or pacing of injected hindrance and therefore FH/AF experienced by participants would affect their engagement with the game that they had been asked to play.

6.2.2 Hypotheses

We had drawn from the literature introduced in chapter 2 to identify both unending success and unending failure as a source of frustration to video game players. With that in mind, our high-level hypotheses were driven

by the belief that both constant success and constant failure would be less engaging than well-paced alternation of success and failure.

The extent to which we could anticipate different levels of engagement experienced by players using the second and third versions of the game, described above, were limited by the scarcity of comprehensive, predictive models of pacing in the literature. Multiple assertions of the importance of pacing exist e.g. Milam et al's work, but we were unable to find causal explanations of the optimal frequency of success and failure whilst designing this study.

In that context, our high-level hypotheses were that:

- Participants experiencing no failure would report significantly lower engagement than those experiencing combinations of success and failure

- Participants experiencing no success would report significantly lower engagement than those experiencing combinations of success and failure

6.2.3 Method

Design

Guided by this literature we designed a study that exposed different groups of players to forced hindrance and therefore experiences of FH and AF.

Materials

To gain a suitable number of participants for this study, the decision was taken to administer this study remotely. This allowed participants to complete the study without the need for our presence.

Participants

In total, this study had 40 participants. All four of the cases had an equal number of participants (10). As with the information study, all instructions to participants were delivered both in game and prior to playing. As stated before, players were not sent the exe file directly. Instead participants were sent a readme file with a link to the file at the end of the document once players had read the instructions. Before the game begins, the player must read through these instructions again in-game. This ensures players are fully aware of the rules of the study. Participants were asked to only play the game once, and were also asked not to quit the game mid play-through, as this would not provide usable results. Players who did play more than once would be flagged since the email client used groups emails received from the same participant. Any playthroughs originating from the same player would be ignored, other than the first. Links were only sent to trusted participants. These were friends and those within the university. This ensured there was no exploitation of the study's structure.

Procedure

Participants were asked to ensure they had access either to certain hardware for this study. They needed either a dedicated hardware mouse, or a game controller with dual analogue sticks. These were the only supported control methods. A touchpad mouse would introduce unwanted difficulty and frustration to the game's challenges. Participants were asked to undertake the study in private, in an environment where they would not be distracted by others and where others would not be able to provide input or advice.

Participants were given information about the study before starting to play the game. Each participant was told that they would be playing the

Table 4: Questionnaire Questions

Number	Question Text	Answer Type
1	I am enjoying the game	7 point likert
2	I am finding the game frustrating	7 point likert
3	I felt the game actively hinders me from progressing	7 point likert

game from the start, and that they would be asked to stop playing and answer questions at set points during the game. In each case they would be asked to answer questions only on the basis of their experience in the most recent period of gameplay i.e. they would be asked to report on their experience since the last pause point, rather than for a summary of their experience to date.

Participants were briefed on the game's controls in a document supplied along side the game's executable file. Where appropriate, context sensitive prompts are displayed on screen, such as 'press W to run forwards'.

We chose to include 6 jumps per phase of gameplay and to stop the game after each phase. Each time the game stopped participants were asked to complete the Questionnaire (shown in Table 4, below) before continuing with the next section i.e. the same questionnaire used in the two previous studies reported in this Thesis. There was no time limit for this study.

Participants were given time to familiarise themselves with the study questions in advance. This helped them answer the questions quickly in the study. In other words, we designed the process governing the questionnaire to avoid taking participants away from the game for too great a period. Also as before, participants used 7-point Likert scales to report on their own sense of being hindered, frustrated and engaged. The small number of questions ensured that the questionnaire could be answered quickly. This maxim-

ised time spent playing the game and minimised the time spent answering questions.

Reporting

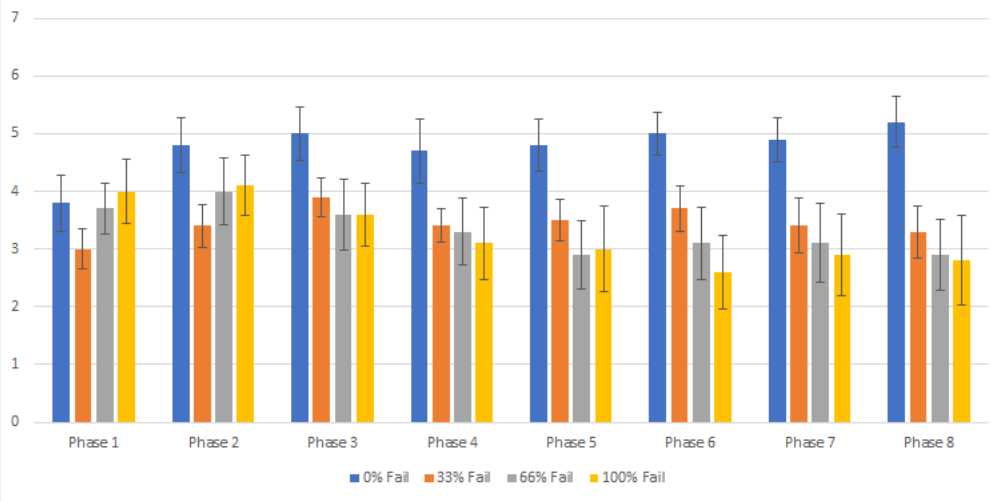
Owing to the volume of cases and required number of participants, the remote system used in the previous study was redeployed for this study. This allowed large numbers of players to participate more easily. A different executable file was produced for each version of the game, and participants were assigned a case executable at random. An email system was used to collect results. When the game itself stops at the interval points, it does not allow the player to continue until they have answered the questions presented. Upon answering all questions, players can confirm their answers by pressing an on screen button. The button does not function if a question remains unanswered, making it impossible to continue without doing so. Once all are answered and submitted, the game continues and the timer continues. Once the end point of the study has been reached, the game collates the results, thanks the player and closes itself. This automatically sends an email to a dedicated inbox containing a string with the participant's responses. No additional personally identifying information was sent.

Once the player had completed a questionnaire for each phase of gameplay, they were asked to press a button to submit their results. Players were encouraged to confirm they had completed the study by email. In the event that the results had not been received, players were asked send the game's log file. Results could be then manually retrieved from it.

6.3 Results

The study's results showing interesting outcomes with respect to the hypotheses. There was a large quantity of significant data in all four study cases throughout the study. These results are presented in graph format in figures 16 through 20. Full results data is reproduced in Appendix B.

Figure 16: Results for mean engagement in all conditions, per phase
Error bars represent standard error.



In overall results, mean engagement was reported at 3.703, with a standard deviation of 1.853. Mean feeling of hindrance was reported to be 4.403, with a standard deviation of 2.083. Observing the results for individual participants (see Appendix B for this data in full), most participants in the 0% and 33% forced hindrance conditions reported largely consistent scores for engagement and FH throughout, fluctuating up and down by 1-2 points throughout. However for the 66% and 100% conditions a more frequent downward trend appears in many players for engagement and a sharply increasing trend for FH, especially in the 100% hindrance condition. Figure 19 shows the mean overall engagement, AF and FH per condition in the study. Note how each of the conditions with forced hindrances shows an

Figure 17: Results for mean annoyance at forestallment in all conditions, per phase

Error bars represent standard error.

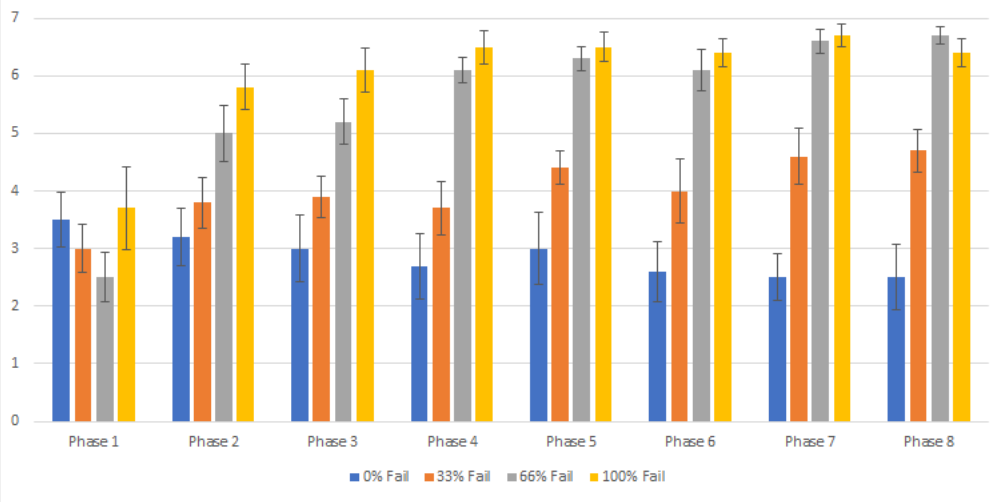


Figure 18: Results for mean feeling of hindrance in all conditions, per phase

Error bars represent standard error.

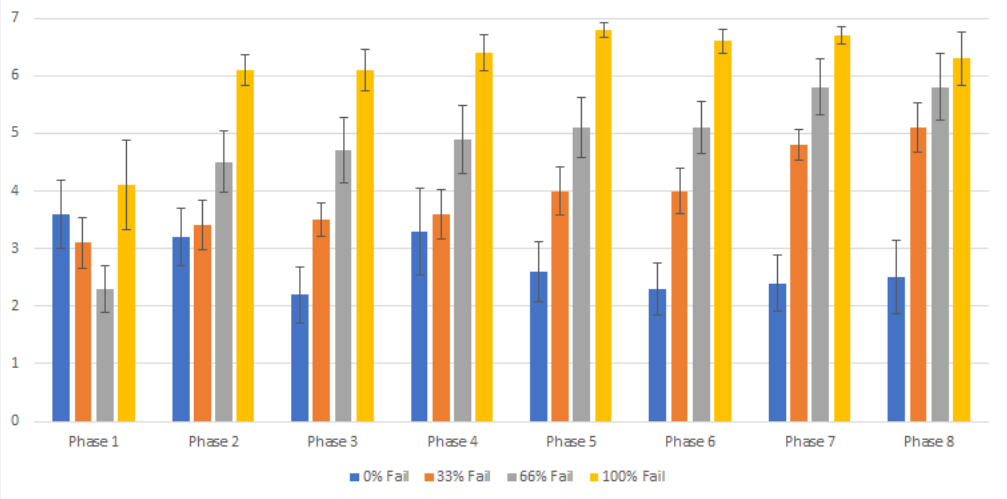


Figure 19: Results for mean overall engagement, annoyance at forestallment (AF) and feeling of hindrance (FH), per condition

Error bars represent standard error.

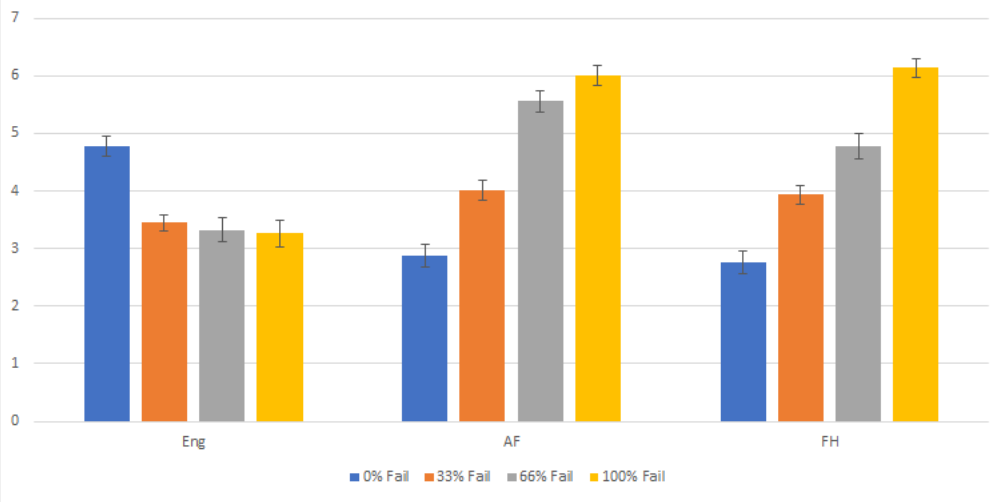
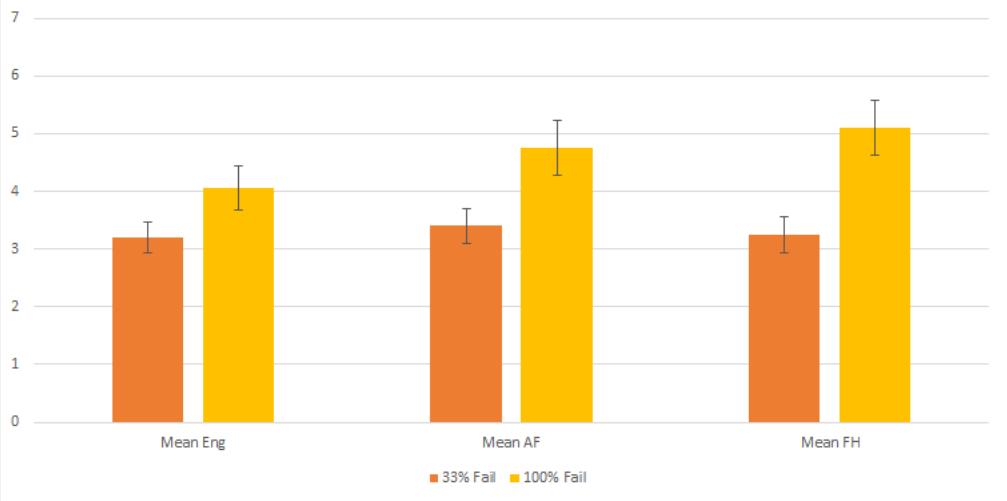


Figure 20: Results for mean engagement, annoyance at forestallment and feeling of hindrance in the 33% and 100% conditions when considering the first two phases

Error bars represent standard error.



increasingly large decline in engagement relative to the 0% condition, and increasingly large increases in AF/FH relative to the 0% condition.

A potential ceiling effect was observed in a small number of cases. The effect was seen most frequently by participants of the 66% and 100% forced hindrance condition's hindrance scores, with a corresponding floor effect for engagement. For example, participant P35 reported a score of 1 for engagement throughout the study, and a score of 7 for FH. As with other studies, these effects are a concern as they may represent times at which potential granular detail is being lost, since there remains no room for the participant to add or remove points to their answers should the situation cause their feelings to become stronger. To some extent this was to be expected as due to the design of the study deliberately trying to cause FH and AF throughout most cases. Regardless, these effects will be reviewed in future studies.

Feeling of Hindrance

Considering Feeling of Hindrance first (one of the three variables we measured in this study's questionnaire), there were no unexpected reports of FH in any phase. The condition featuring 33% deliberately introduced hindrance reported in a one tailed Mann-Whitney-Wilcoxon test, a significant increase in FH of $p < 0.0001$, from a mean of 2.723 increasing to 3.938, relative to the base condition. The condition featuring 66% deliberately introduced hindrance reported a significant increase in FH also of $p < 0.0001$, increasing to 4.776, again relative to the base condition. The condition featuring 100% deliberately introduced hindrance also reported a significant FH increase of $p < 0.0001$, increasing this time to 6.138, again relative to the base condition. Note the large difference in FH between the 0% fail bar for FH

shown by figure 19 and each subsequent bar for the increasingly hindering conditions.

These increases in FH were also reflected in phase to phase results. Note the consistent increasingly large gaps between the 0% fail bar and the bars for other conditions in each phase in figure 18. The 33% condition reported such a result in 5 phases, including $p = 0.0352$ and $p = 0.0375$ in phases 3 and 6. The 66% condition reported significant differences also in 5 phases including $p = 0.0057$ and $p = 0.0045$ in phases 3 and 5. The 100% condition reported significant differences in 7 phases, including $p = 0.0005$ in phase 2, $p = 0.0003$ in phase 3 and $p = 0.0057$ in phase 4.

Some significant increases in FH are also visible when contrasting each condition with increased deliberately introduced hindrance to the next. Each time that free play without deliberately introduced hindrance is reduced, FH was further significantly impacted. For example, contrasting the 33% condition with the 66% condition demonstrated a significant increase in FH with $p = 0.0008$. Moving from 66% to 100%, a significant difference was also seen, with $p < 0.0001$. This is also reflected in comparisons between like phases in different cases, such as phase 7 between the 33% and 66% case ($p = 0.0188$), and phase 2 and 4 between the 66% and 100% conditions ($p = 0.0375$ and $p = 0.0037$).

It is also interesting to contrast results at points with concurrent numbers of deliberately introduced hindrances. At several points in this study, participants in different conditions had encountered the same number of deliberately introduced hindrances. For example, in phase 6 of the 33% condition and phase 2 of the 100% condition, all participants had encountered 12 forced failures. However, participants reported significantly different FH at this point of $p = 0.0016$. After phase 6 of the 66% condition and phase 4 of

the 100% condition both result in the player having experienced 24 failures, with a resulting $p = 0.0244$ significance for FH. In both cases, mean FH was higher in the condition with greater concentration of deliberate hindrance - 4 versus 6.1 in the first example, and 5.1 versus 6.4 in the second. This demonstrates the effects that pacing can have on player perceptions of how hindered they are, making them report greater levels of hindrance if the interventions are delivered more quickly or frequently.

Annoyance at Forestallment

With respect to player reports of Annoyance at Forestallment (one of the three variables we measured in this study's questionnaire), there were no unexpected reports of AF in any phase. The condition featuring 33% deliberately introduced hindrance reported an increase in AF of $p < 0.0001$, from a mean of 2.875 in the base condition to a mean of 4.013 in this condition. The condition featuring 66% deliberately introduced hindrance reported an increase in AF of $p < 0.0001$, to a mean of 5.563 from the same base condition. The condition featuring 100% deliberately introduced hindrance reported an increase in AF of $p < 0.0001$ as well, to a mean of 6.013 from the same base condition. Note the large difference in AF between the 0% fail bar for AF shown by figure 19 and each subsequent bar for the increasingly hindering conditions.

Significant increases in AF are also observed when contrasting each condition with increased deliberate hindrance to the next. Note the consistent increasingly large gaps between the 0% fail bar and the bars for other conditions in each phase in figure 17. The 33% condition reported a significant difference in AF in 2 phases, with $p = 0.0057$ in phase 7 and $p = 0.0096$ in phase 8. The 66% condition reported significant differences in 7 phases,

including$p = 0.0158$ in phase 2, $p = 0.0078$ in phase 3 and $p < 0.0004$ in phase 4. The 100% condition reported significant differences in 7 phases also, for example $p = 0.0023$ in phase 2, $p = 0.0018$ in phase 3 and 0.0003 in phase 4.

Significant increases in AF are also visible when contrasting each condition with increased deliberately introduced hindrance to the next. As before, each time the volume of free play in a condition is reduced, the player's AF levels also increase, in line with the behaviour exhibited by hindrance. Contrasting the whole of the 33% condition to the whole of the 66% condition demonstrates a significant difference of $p < 0.0001$(rising from a mean of 4.0125 to 5.5625), while the 66% condition contrasted against the 100% condition shows a significant difference with $p = 0.0179$ (rising from a mean of 5.5625 to 6.0125). Additionally in comparing like phases, similar results were seen. For example the 33% condition showed a significant difference to the 66% condition in 6 phases (e.g. $p = 0.0244$, $p = 0.0014$ and $p < 0.0004$ in phases 3, 4 and 5 respectively).

As with results for hindrance, there are interesting results at points where participants in different conditions had encountered equal numbers of deliberately introduced hindrance. One condition (phase 6 of 33% versus phase 2 of 100%) showed $p = 0.0116$ significance with means of 4 and 5.8. Additionally after phase 8 of the 33% condition and phase 4 of the 66% condition, there was $p = 0.007$ significance for AF, with means of 4.7 and 6.1 respectively. Collectively with the results for hindrance, this is further evidence that the speed and frequency a player experiences hindering events at will influence how much AF they report feeling.

Engagement

Continuing to results for engagement, FH and AF were a continuous presence in this study irrespective of the participant's engagement levels. This is in keeping with the results reported in the first two studies in this thesis. Though some participants reported a floor effect in some cases (for example P21 in the 66% condition reported engagement of 1 for phases 3 through 8), results consistently displayed that some degree of engagement was continually present for the majority of participants (see figure 16 for a graph of mean phase to phase engagement across all conditions. Note how in most cases, engagement is strongly reduced compared to the 0% condition, but far from zero). However, there were also some participants who even found the 100% failure condition highly engaging; P33 scored a 7 for engagement in all but one interval, while P39 showed a score that fluctuated between 5 and 7 throughout, and P34's score ranged from 5 to 3, with most results scoring a 5. One explanation is that it is possible that these players became very engaged through the desire to complete even one jump before they reached the end of the study. Participants, due to the design of this study would not know it was impossible to do so. Participants would likely come close to success each time, however, perhaps making them think success may be possible.

We found some significant evidence which directly suggests that increasing the pace at which the player encounters FH and AF will lead to additional engagement in players. Engagement across the four conditions does generally behave as one would expect per the relationships discussed in chapter 2.3.1 of the literature review. Engagement generally drops as FH and AF increases. Each condition with deliberately introduced hindrance saw a significant decline in overall engagement from the base condition. Each of these

three conditions reported a decline with $p < 0.0001$. The declines are from a mean of 4.75, to means of 3.45, 3.325 and 3.263 respectively. Note the large difference in engagement between the 0% fail bar for engagement shown by figure 19 and each subsequent bar for the increasingly hindering conditions, as well as in figure 16, which also shows a noticeable decline in engagement relative to the 0% condition in most phases in all conditions.

However when considering the opening of the game only, a different picture of engagement emerges. When contrasting the 100% condition against the 33% failure condition, the first two phases of the game are significantly more engaging than those of the 33% condition. This contrast occurs at $p = 0.0384$ significance, with a mean engagement of 4.05 in the 100% condition but only 3.2 in the 33% condition. The opening two phases of the 100% condition also feature a mean AF of 4.75 in contrast to 3.4 in the 33% condition, with significance $p = 0.0207$. In addition we see a mean FH of 5.1 in the first two phases of the 100% in contrast to 3.25 in the 33% condition, with significance $p = 0.0021$. This is best reflected by the graph in figure 20, which shows the mean engagement, FH and AF in this isolated period for the 33% and 100% conditions; note the increase in engagement, FH and AF in the 100% condition.

Therefore at the beginning of the game, despite participants of the 100% condition finding the game significantly more hindering, and significantly stronger feelings of AF, they also found the game significantly more engaging all the same. This increased engagement does not of course last the entire duration of the game, but this is significant evidence that players can enjoy a game which features increased FH and AF relative to another, albeit only briefly in this instance. This does not support either hypothesis outlined prior to this study, in which we expected that the 0% and 100% condition's

participants would both be less engaged than those of the 33% and 66% conditions. We had expected that we would observe increased engagement in some of the conditions which featured faster injected hindrance pacing, but not that it would occur in the 100% condition. Nonetheless, this is a positive result for this research, showing that it is possible to deliberately induce player FH and AF in such a way that players will enjoy it more than without.

6.4 Discussion and Conclusion

This study hypothesised at a high level that pacing might play a key role in how FH/AF affects the player's engagement level in games. In the context of the results described in the study in the previous section, we reconsidered whether our candidate description of FH and AF as a potentially positive influence in player engagement was flawed. When considering the results of the first study (where players experienced heightened FH and engagement in correlation with one another) and the last study (where players were able to enjoy heightened FH and engagement for at least a brief period), we decided to consider the role other factors identified as potentially important by the literature review also played in potentially creating the suggested (and observed in the first study) relationship.

This study therefore aimed to consider, in the light of factors raised in the literature review, the importance of pacing of events that cause FH and AF in the impact FH and AF have on player engagement. We hoped to discover whether an increased rate of injected hindrance in a study environment could lead participants to report increased FH/AF and engagement in tandem. The results of this study reported that this result can indeed occur; we were able to observe instances in which participants reported significantly

increased engagement at the same time as significantly increased FH and AF. Though this effect was observed only in the short term in this study, this nonetheless allows us to consider these results as important toward developing the candidate notion that frustration is a factor developers could deliberately introduce to a game in order to heighten player enjoyment. This has obvious implications for developers of games, since this extends the existing causal descriptions of FH and AF's effects on engagement to be one which is not exclusively negative. Where previous causal descriptions and research have suggested mitigating and eliminating frustration where it is found, these results suggest to developers that removal of frustration may not always be the best approach in attempting to create a highly engaging play experience.

With respect to existing perspectives on FH and AF's effects on player engagement there was nonetheless some support for the suggestion that FH/AF and engagement are opposite factors to one another and that FH/AF occurs where engagement fails (covered in chapter 2.3.1). In addition to injected hindrance increasing player reports of FH levels consistently in this study, it also resulted in reports of significantly increased AF levels. Moreover, each condition in which we injected hindrance was overall less engaging than the condition in which we made no interventions other than to ensure that the player never experienced hindrance. Despite this, the overall results contest this view. We do not suggest that player FH/AF will *always* be a positive influence on player engagement, but that when utilised in the right manner, it can be a positive influence. As with previous studies, FH and AF were an ongoing presence throughout the study, even when players were reporting high levels of engagement. They did not occur only when players were not engaged with the game. Most significantly, a portion of

the game which was extremely strong in FH and AF was found to be significantly more engaging than one which was less hindering and frustrating, which directly contests the views expressed in chapter 2.3.

We also found significant support for the view expressed in chapter 2.4 that FH and AF can be a tool deliberately deployed by games developers in order to result in increases in player engagement. We observed that at the beginning of the game, participants taking part in the condition which featured the highest volume of injected hindrance were significantly more engaged than participants in another condition which had considerably less injected hindrance. The more engaging condition caused players to face injected hindrance at very single opportunity possible; a very high rate of injected hindrance. The less engaging condition caused players to face injected hindrance at only 33% of the available opportunities, meaning the more engaging condition inflicted FH/AF on the player at a rate 3 times higher than the other condition. In addition to this significant increase in engagement, participants were reporting significantly more FH as expected, and significantly more AF.

A drawback of this result was that this effect was not prolonged. Though players enjoyed this extreme FH and AF to begin with, their engagement rapidly declined. The increase in FH/AF was therefore not sustainable in this study. To some extent this is an expected outcome; in this early stage participants may have enjoyed the frustration because they enjoyed attempting to overcome the challenges placed before them. However as time progressed it may have become clear to them that it was very unlikely they would prevail at any of these jumps. Prolonged exposure to extreme frustration is generally not expected to be enjoyable, however these results demonstrate it can be enjoyable in the short term.

There are some immediate implications of this result with respect to both game developers and academia. Most clearly these findings further suggest a need for extension to existing causal descriptions of how FH/AF affect the player's feelings of engagement when playing a game. Though the relationship where FH/AF and engagement are opposites *can* occur, it is increasingly clear that this will not always be the relationship. Further thought should instead be given to consideration that engagement can in fact be enhanced at times by FH/AF instead. For developers, this means a need to pay deeper consideration to feelings of FH or AF reported by players. If players are reporting high levels of FH/AF for brief periods of time, it may not be the correct approach to address this feeling if players still feel engaged, since there is a risk that this report of FH/AF is in fact responsible for the engagement they are also feeling.

Therefore a key focus of the subsequent research will be to discover whether a more mild condition of FH and AF can also yield increased engagement among players relative to other conditions with even lower FH and AF, but over longer periods of time instead of the rapid decay this study has exhibited. In this future research we will need to take into account some of the shortfalls in the approach taken in this study, in particular the calibration of the conditions we chose for this study. It is not clear that conditions of 33%, 66% and 100% hindrance injection were the right levels for this experiment in hindsight. Though these conditions did provide us with insight on the effects of pacing across the maximum possible spectrum of saturation it can occur at, it is possible that different outcomes may have been observed if we had featured a greater number of milder conditions as well. The subsequent chapter will consider both of these topics further.

To conclude, this study was able to induce the behaviour expected and

described in chapter 2.4 and 3 of the thesis- that players who encounter significantly increased FH and AF can also report significantly increased engagement at the same time, rather than this always being a negative outcome. In this instance, such an effect was created through control of player pacing. However, this effect was only seen in the short term before quickly subsiding and giving way to a negative effect on player engagement. However, there remain factors raised in the literature review that have not yet been considered in empirical study. One of these factors is variety. We note that in this study, participants encountered injected hindrances at a consistent rate throughout. These results combined with the literature lead us to consider whether a varied source of FH/AF could help produce a more sustainable positive player reaction to FH/AF in games. These investigations are described in detail in the subsequent chapter.

7 Study 4: Investigating Variety and Frustration

In the last chapter we described a study investigating the role that pacing plays in player reception of feeling of hindrance and annoyance at forestallment in games, by carefully injecting hindrance at different intervals within a game. It was expected that some small amount of deliberate FH/AF applied infrequently would be less frustrating or hindering than applying it frequently or not at all. Support was found for the general hypothesis that exposing players to increased pacing of FH and AF could result in increased player engagement. A condition which featured increased pacing of injected hindrance yielded a short term rise in player FH, AF and engagement. Encouraged by these positive results, we sought to uncover further factors which could result in similar positive changes in both FH/AF and engagement.

Pursuant to the lessons learned in the prior study, we once again returned to the literature introduced in chapter 2 in order to uncover further frustrating elements of gameplay which may be able to induce increased player engagement instead of a decrease. In particular we focused on literature which described the importance of variety in player engagement, something considered important by authors such as Cowley et al and with a significant volume of supporting literature demonstrating both the potential benefits of variety in players. We considered the extent to which varied delivery of hindering moments in games and therefore FH/AF in games could induce players to enjoy the variation instead of falling into monotony (suggested by Rauterburg), which we speculated may have been part of the reason the primary hypothesis in the previous study was not realised.

The body of knowledge established in the literature as well as the learnings from our previous studies facilitated the design of the present study. Studies in the review reported the importance of variety in both games and other contexts, however there is a lack of comprehensive models of how to utilise variety in literature, in particular in relation to the FH/AF arising from varied frustration sources impacts the player experience. However, authors such as Fabricatore recommend utilising 'satellite mechanics' which build upon existing notions of gameplay, while others such as Milam et al observed how many popular games repeat patterns of a small number of gameplay types. Successful games do not appear to have a wide variety of core mechanics, but instead only a few core mechanics which use smaller satellite mechanics to add novelty.

Following this literature we designed a study which exposed different groups of players to different approaches to variety, and different orders of variety of gameplay elements which were known to cause FH and AF in players, mirroring and not mirroring descriptions of successful pacing in games. Participants were asked to complete a 3D puzzle game consisting of the same type of puzzles as the information study described in chapter 5, which were known to induce FH and AF. However many participants experienced a variety of modified versions of these puzzles, instead of the same type of puzzle all the way through the game. It was expected that participants who experienced a varied pattern of throughout the study would be more engaged and frustrated than those who experienced no variety, since the literature described in chapter 2 had outlined that both following existing causal descriptions of engagement, and introducing variety would introduce both engagement and FH/AF.

7.1 Game Design

7.1.1 Overview

A suitable game was again needed to provide a study environment in which we could test the effects of variety of feeling of hindrance and annoyance at forestallment on player engagement. We identified the key necessary characteristics as follows:

- The game must provide a direct way to inject variety through changing the type of FH/AF generation a player will encounter
- In all aspects other than the FH/AF generating event a player is facing at a given moment, the study cases must be as identical as possible
- The chosen game would need to be accessible to a range of participants by being easy to pick up and play without an extensive learning period
- The game should be easily deployable in a study environment

A great degree of control over the game in this study was required. Not only was a way to drive FH/AF in game necessary, multiple sources of FH/AF were needed which could drive variety in game. Additionally, the FH/AF sources needed to feel substantially different to players. Players needed to actually recognise that the game was varied such that they would acknowledge them as varied. On top of this, it remained true that the game needed to be accessible to new players. I did not want to have to spend significant time training the player to play the game. Various games were considered in order to find a suitable game for these criteria. Ideally, the game would feature a single key mechanic redeployed in various ways to create variety. Some games fit this criteria such as The Witness. However this game had been discounted in a previous study already. The game is not

easily modified and does not give enough control over its content as a result. It would not be easily deployed in a study environment. Other games also failed to give enough control. Variety was commonly present, but cases with no variety were rare. No game made it easy to switch between one case or the other. The game needed to be mostly identical between groups of players whether they experienced variety of not. The intention with this study was that different groups would play the same segment, with only minor details adjusted.

Since no suitable game was found, it was again decided to create a game for the purposes of this study. This time however, some elements from previous studies were utilised. The information study's results had shown the puzzles used were able to generate FH and AF in various combinations. The results had also shown players needed to take different approaches to these different configurations. This would therefore be a good source of variety for players. The study therefore used these puzzles, but in a new context and configuration. They were used to drive variety while maintaining consistency across the remainder of the game.

7.1.2 Puzzle Design

For this study, we decided to reuse components of the game introduced in the second study (reported in Chapter 2). No participants who had been involved in Study 2 took part in this one.

In the information study, players worked through an environment containing a series of 'puzzle panels'. These must be solved in order to progress through the study game. Interacting with the panel would allow them to click the buttons to cycle through their colours. Pressing a larger solution button to the side of the puzzles would check if the player had solved the

puzzle. Pressing this button would also cause the individual colour buttons in the puzzle to flash either red or green. This colour was dependent on whether or not that individual square was the correct colour or not. For each puzzle, a clue was placed somewhere in the environment which revealed the colours the buttons needed to be set to in order to solve the puzzle. Lower preparatory information and low feedback versions of the puzzles were also created. The former removed the clues from the game. The latter removed the colour flashes when the solution button is pressed. See figure 7/8/9 in chapter 5 for images of these puzzles.

In keeping with the design of study 2, on arrival at an individual puzzle, players were provided with grey-coloured buttons. They were then asked to use their mouse to click on the grey buttons. In order to cycle the colouring of the button in question through a pre-set list of colours. The objective in each case was to keep pressing buttons until the colours on the panel matched those on the clue . Once the player was convinced that a solution had been reached, they pressed a separate button to indicate that they wanted feedback. If the puzzle had been completed successfully i.e. all colours matched those required a door opened in the environment and the player was able to progress to the next puzzle. See figure 10 in chapter 5 for an example of this.

If the player had provided an incorrect solution the buttons showing an incorrect colour were programmed to flash briefly in red (a colour that had not been used elsewhere in the game design) whilst an alarm sounded. The combination of flashing lights and alarm was the primary source of feedback in this study, as it had been in Study 2.

7.1.3 Environment and Progression Design

A game environment was created within which the puzzles could drive variety. The environment could also accommodate for how measurements of emotion would be made in this study. Rather than being collected at 2-minute intervals, the data would be collected after set gameplay segments. The environment was therefore designed such that it was more clearly segmented. This naturally created points at which questions could be asked and variety introduced. It also reflected the design of games like Limbo. Limbo waits until breakpoints in the action before introducing variety, and so does this study. Questions would be put to participants immediately after completing a section of the game. This ensured their feelings could be captured immediately after experiencing a varied segment. After each further burst of variety, they would answer questions again.

The study's design facilitated this goal by dividing the game environment into a sequence of rooms. Each room featured a pair of puzzles. Each room also featured a locked exit. The exist could only be opened by correctly solving both puzzles within. These locked doors provided the points at which both questions would be asked and variety would be injected. Every time the player enters a new room, the type of puzzle is switched (if the participant is playing one of the varied study cases). They are then asked questions about the experience. Every time the participant has finished experiencing a variation, their thoughts are immediately captured and a new variation is created.

A key difference in this study to the information study was the role of the first room in the study. In the information study, participants encountered the same type of puzzle throughout the game. This study specifically tests the effects of introduction of hindrances that lead to FH/AF which are

varied. Previous studies have not featured variation of the inject hindrance within a single study case. In the information study, whichever type of puzzle the player encounters in their given case is the only type of puzzle they ever encounter. Therefore, the presence of FH/AF is not 'introduced' at any point, it is simply the default mode of the game, regardless of which puzzle type they are seeing. In this study, even in the non varied cases, the first room is identical across all cases. In the first room is two puzzles with full preparatory information and feedback. In subsequent rooms, low preparatory information and low feedback versions are introduced. This allows for the testing of the effects of the introduction of non-varied in-game hindrances versus varied in game hindrances and the differences in the levels of FH/AF. This approach answered some concerns in the design of the study. There was a danger than whichever puzzle type was encountered first would be considered 'normal' by the player. The other type of puzzle might then be considered the frustrating puzzle since it was different. Opening with a baseline room in all cases establishes in the varied cases that both puzzle types are FH/AF generating potential hindrances. In addition, these puzzle panels were also chosen because they mirror observations by Fabricatore in the literature relating to satellite mechanics and variety - a challenge derived from another the player is familiar with is less likely to negatively impact frustration when used as a source of variation in gameplay than one which is totally new to the player. Each frustrating puzzle variety is derived from the one the player already experienced once.

7.1.4 Game Variations

This resulted in the following four study cases:

1. NoFeed - Following an initial baseline chamber, each chamber there-

after contains only puzzles with low feedback.

2. NoInf - Following an initial baseline chamber, each chamber thereafter contains only puzzles with low preparatory information.

3. AltInf - Following an initial baseline chamber, each chamber thereafter alternates containing puzzles with low preparatory information and low feedback, beginning with the former.

4. AltFeed - Following an initial baseline chamber, each chamber thereafter alternates containing puzzles with low feedback and low preparatory information, beginning with the former.

Some additional elements were added to the game's design following pilot tests. These elements helped communicate to players in the varied cases that the puzzle's mechanics had changed. This prevented players resorting to trial and error to realise that the puzzles had changed. Participants often spent significant lengths of time looking for non-existent clues in chambers featuring low preparatory information in pilot runs of the study. This generated massive amounts of frustration that were not intended to be present. It was decided to make changes as a result of this. The intention was that the frustration generated by the low information puzzle should be from having to work out the solution when the player knows there is no preparatory information. Any added frustration was to be avoided to allow clear comparisons to other conditions. A pair of markup symbols were created to quickly communicate this to the player. In low preparatory information puzzles, the clue is covered with an X symbol. In low feedback puzzles, a crossed out flash symbol is shown next to the puzzle (see figure 21 for images of these hints). Pilot runs clearly established players quickly understood the meanings of the symbols. This ensured that the frustration generated by

Figure 21: The puzzles with symbols showing that there will be no feedback and no information, respectively.

the varied puzzles is generated by the difference in puzzle mechanics created by the removal of information. The frustration was not due to a feeling of unfairness created by giving the player no indication that the gameplay method had changed.

7.2 Study Design

7.2.1 Aim

The aim of the study reported in this chapter was to investigate the utility or otherwise of the idea that varying the in-game hindrances which were the

source of the frustration (FH and AF) encountered by participants would cause that frustration to generate engagement ('beneficial frustration'). In other words, the aim here was to investigate the idea that variety of frustration source was a key component of beneficial frustration.

7.2.2 Hypotheses

Our high level hypothesis for this study was that.

- Players experiencing frustration (FH and AF) from multiple types of in-game hindrance (variety) would report greater engagement with the game than those experiencing frustration (FH and AF) from a single source (monotony)

7.2.3 Method

Design

Four versions of the game were created. Each version contained different combinations of preparatory information and feedback.

Preparatory information was comprised of:

- The clue panel

Feedback was comprised of:

- The confirmatory flashes of the puzzle buttons when pressing the solution button
- The accompanying correct/incorrect sound after pushing the solution button

The four versions of the game were:

- Case A (NoInf): A version in which reduced preparatory information was presented without variation throughout the game.

- Case B (NoFeed): A version in which reduced feedback information was presented without variation throughout the game.

- Case C (AltInf): A version in which the first puzzle encountered contained only feedback and no preparatory information, the next contained preparatory information and so on (variety, starting with feedback).

- Case D (AltFeed): A version in which the first puzzle encountered contained only preparatory information and no feedback, the next contained feedback and so on (variety, starting with preparatory information).

In order to prevent the occurrence of learning between conditions, we designed a between-subjects study, involving four conditions (one for each version of the game). Participants were asked to complete the game in one condition i.e. using one version of the game. Participants were randomly allocated to conditions.

Armed with these different versions of the game, each designed to frustrate players to greater or lesser extent, we were able to finalise operational hypotheses as follows:

- H1: Participants in conditions C and D (i.e. those encountering a variety of frustrations) would report significantly higher levels of engagement than those in condition A and B (i.e. those encountering monotonous frustration).

Participants

This study had 40 participants, with an equal number of participants in each of the four cases. The previously established process of delivering the study remotely was used. Participants were reminded to only complete the study once. Participants were sourced from the University, work colleagues and trusted individuals from the games community. These sources ensured participants could be trusted to play the study through only once. If players encountered any problems mid play through, they were asked to not begin again even if they were willing to. Prior knowledge of the game's contents would have a negative effect on results.

The results submission system would make it clear if players did play multiple times. Emailed results from the same device would be grouped together in the email client automatically. This made repeat playthroughs obvious. Players were also asked to ensure they had a physical mouse present when playing. Solving the puzzles using a touch mouse or similar type of device would likely be a source of frustration which was not a focus in this study. Colour blind candidates were advised not to participate. The nature of the game's colour matching puzzles meant attempting to solve puzzles while colour blind was judged to be a source of frustration not under this study's remit.

Players were asked to send a message to the administrator of the study after completing the study. This helped us to be certain determine that their results had been correctly submitted. Participants were asked not to delete the game's data folder until a response had been received from the administrator. In cases that the email did not send correctly, players were asked to find a log text file from within the data folder and send it, as the correct result could be extracted from this file. Players were then asked to

delete the game from their system.

Procedure

Participants were given information about the study before starting to play the game. Each participant was told that they would be playing the game from the start, and that they would be asked to stop playing and answer questions at 7 points during the game. In each case they would be asked to answer questions only on the basis of their experience in the most recent period of gameplay i.e. they would be asked to report on their experience since the last pause point, rather than for a summary of their experience to date.

Participants were briefed on the game's controls in a document supplied along side the game's executable i.e. Where appropriate, context sensitive prompts are displayed on screen, such as 'press E to interact'.

Participants were then asked to complete 14 puzzles. The first two puzzles in every condition contained both preparatory information and feedback and were used to allow participants to get familiar with the game, its objectives and controls. The remaining 12 puzzles were then provided with the information listed in the design section above (i.e. only preparatory information in case A, only feedback in case B and so on). The game was stopped each time that participants completed two puzzles i.e. seven times in a fourteen puzzle game.

Each time the game stopped participants were asked to complete the Questionnaire (shown in table 5, below) before continuing with the next section. A play-through length of 20 minutes was targeted, of which participants were informed. The initial exploratory study was longer than this duration. However within a 20 minute period of that study there was signi-

ficant variety of player frustration and engagement. It was thus determined that 20 minutes would be long enough for players to exhibit reactions to the changes present within each condition. This was also reflected in pilot tests of the study. Participants were given time to familiarise themselves with the study questions in advance. This helped them answer the questions quickly in the study. In other words, we designed the process governing the questionnaire to avoid taking participants away from the game for too great a period.

Also as before, participants used 7-point Likert scales to report on their own sense of FH, AF and engagement. The small number of questions ensured that the questionnaire could be answered quickly. This maximised time spent playing the game and minimised the time spent answering questions.

Reporting

It was once again decided to administer this study remotely in order to maximise the pool of participants available to the researcher.

At the start of each condition, players were given a file containing instructions. The file also had a link to an executable file which would run the game once they had finished reading the instructions. After each each room of puzzles had been completed, upon entering the next room players were stopped and asked to answer a set of questions. These were the same questions relating to frustration and engagement posed to players in the previous studies (i.e. the questions provided in table 5). Once the players had filled out all the questions and completed the game, they were able to push a button to submit their results. Players were encouraged to contact the study administrator after participating to let them know they had com-

Table 5: Questionnaire Questions

Number	Question Text	Answer Type
1	I am enjoying the game	7 point likert
2	I am finding the game frustrating	7 point likert
3	I felt the game actively hinders me from progressing	7 point likert

pleted the study so it could be checked that their results had been submitted. In the event that the results had not been sent for some reason, players were asked to send the game's log file so that that the results could be retrieved manually.

7.3 Results

The results showed strong data supporting our hypothesis. Appendix B reproduces these results in full. Figures 22, 23, 24, 25 and 26 visualise those results into graphs for easy comparison of each variable in each condition in each phase.

Figure 22: Results for mean engagement in all conditions, per phase
Error bars represent standard error.

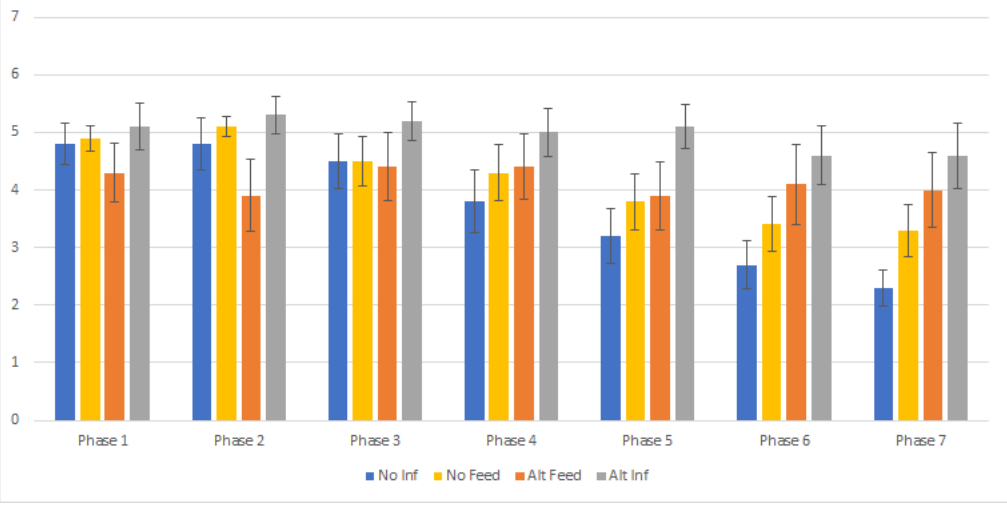


Figure 23: Results for mean annoyance at forestallment in all conditions, per phase

Error bars represent standard error.

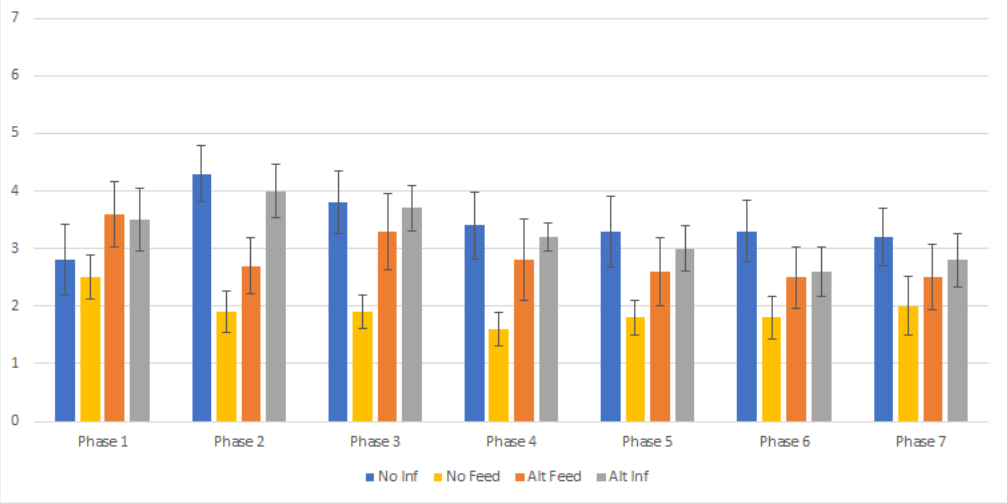


Figure 24: Results for mean feeling of hindrance in all conditions, per phase

Error bars represent standard error.

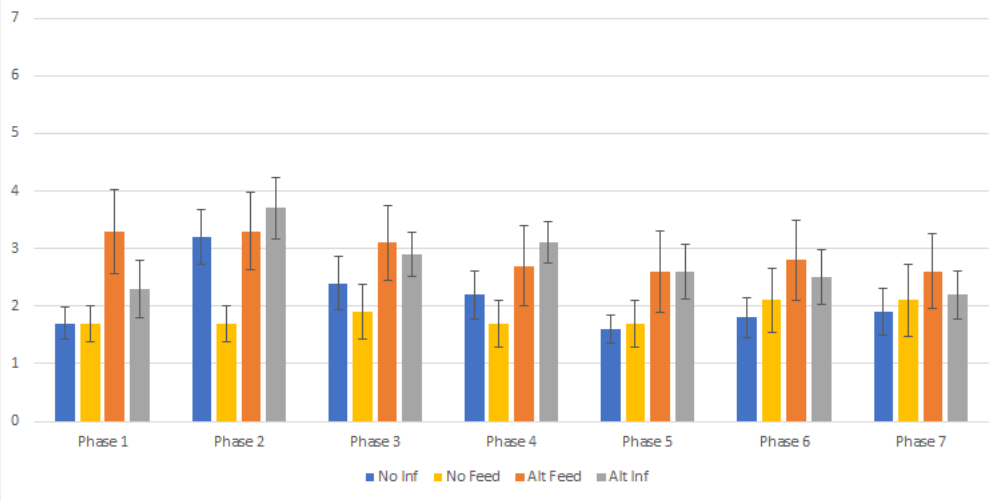


Figure 25: Results for mean overall engagement, annoyance at forestallment (AF) and feeling of hindrance (FH), per condition

Error bars represent standard error.

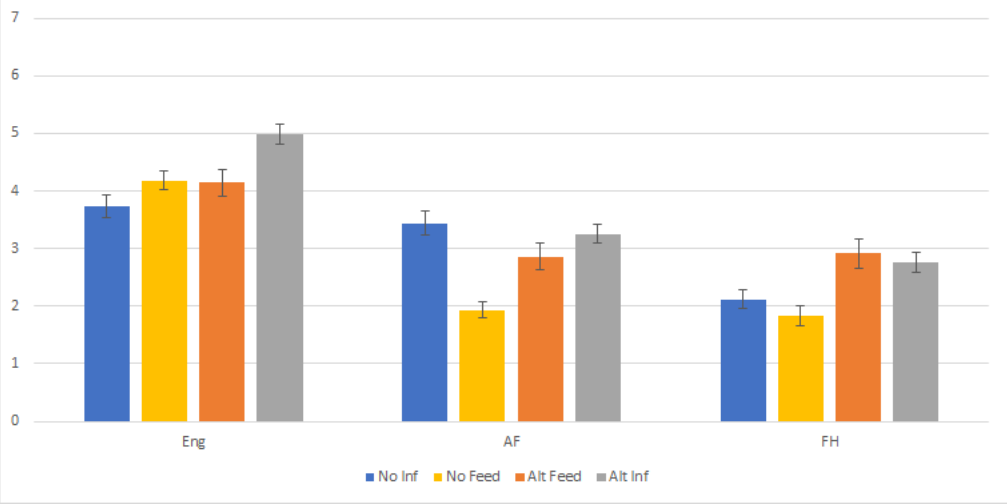
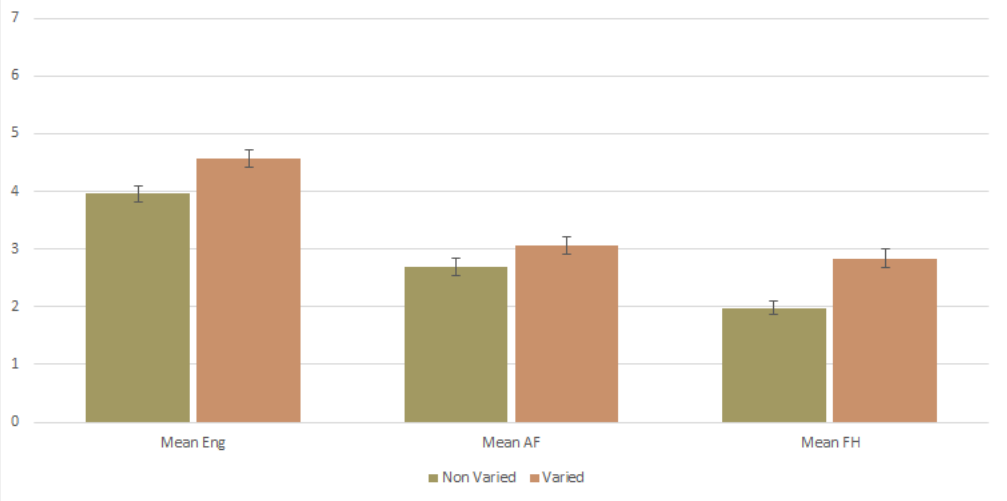


Figure 26: Results for mean engagement, annoyance at forestallment and feeling of hindrance in the when considering varied conditions against non varied conditions

Error bars represent standard error.



As expected, the use of the removal of preparatory information and feedback in the game resulted in significant changes in engagement levels throughout the study. However, the addition of variety in this study caused an interesting change in the relationship between FH, AF and engagement which is not explained by existing causal descriptions of this relationship.

Beginning with the overall results, mean engagement was 4.261with a standard deviation of 0.455. Mean FH was found to be 2.407 with a standard deviation of 0.443. Mean AF was 2.871 with a standard deviation of 1.719. These results show that participants in the cases without variety generally appeared to have a significantly different experiences to those who did not.

Feeling of Hindrance

With respect to player reports of FH, participants of of the conditions featuring variety of FH/AF sources reported an increased level of FH in contrast to the conditions which did not feature variety. Both *AltFeed* and *AltInf* were seen to be significantly greater in FH than the non varied conditions in most cases. *AltFeed* reported $p = 0.0078$ in a one tailed Mann-Whitney-Wilcoxon test when compared to when contrasted with *NoFeed* (in figure 25, note the relative size of the 'AltFeed' bar to 'NoFeed'). Mean FH in *AltFeed* was 2.914, and 1.843 in *NoFeed*. *AltInf* reported $p = 0.0047$ when contrasted with *NoInf* and $p < 0.0001$ when contrasted with *NoFeed* (also in figure 25, note the relative size of the 'Alt Inf' bar to the bars for 'No Inf' and 'No Feed'. Mean FH in *AltInf* was 2.757, again higher than *NoInf* (2.114) and *NoFeed*. No significant difference between the Alt conditions was reported for FH. These results demonstrated therefore that presenting players with a varied selection of interventions intended to create FH and AF would cause players to feel more FH than when facing only a single type of intervention.

Furthermore when considering results as varied conditions contrasted against non varied conditions, we see significance of $p = 0.0002$ for varied conditions reporting greater FH, with comparative means of 2.836 in varied conditions and 1.979 in non varied conditions. Despite players encountering the same number of hindering events in both varied and non varied conditions (with the varied conditions containing the same types of puzzles found in the non varied ones), encountering a mixture of FH sources will cause players to feel significantly more hindered all the same. This is best illustrated by figure 26 - note how the bar for Mean FH in varied conditions is notably larger than the bar for non varied conditions. We noted in the literature review that introduction of variety was likely to result in increased FH, and these results confirm that observation.

Annoyance at Forestallment

Of further interest in this study are results pertaining to player AF. When considering AF, when results were taken as a whole *AltFeed* reported $p = 0.0256$ significance when contrasted with *NoInf*, and also reported $p = 0.0089$ when contrasted with *NoFeed* . The mean AF from *AltFeed* was 2.85, in contrast to 3.443 for *NoInf* and 1.929 for *NoFeed.* *AltFeed* was therefore significantly stronger in AF than *NoFeed*, but also significantly weaker in AF than *NoInf* (in figure 25, note the size differences in the bar for 'Alt Feed' relative to 'No Inf' and 'No Feed'). *AltInf* also reported a significant difference of $p < 0.0001$ when contrasted with *NoFeed.* Mean AF in *AltInf* was 3.25, meaning *AltInf* was also significantly higher in AF than *NoFeed* (in figure 25, note the size difference in 'Alt Inf' relative to 'No Feed').

Furthermore, when considering results as varied conditions contrasted against non varied conditions, we saw significance of $p = 0.0301$ for varied

conditions being higher in AF, with comparative means of 3.057 for varied conditions and 2.686 for non varied condition. Therefore despite players encountering the same number of FH/AF generating events in both varied and non varied conditions, as with results for FH, participants also report significantly more AF when presented a game which uses a variety of frustrating game mechanics. In the literature review's section 2.4.3, we noted that variety could create an increased cognitive burden on players, and this may be reflected by these results. Again, this is best illustrated by figure 26 - note the increase in mean AF between varied and non varied conditions in the central section.

Engagement

Of particular interest in this study are results for player engagement, and how they relate to player FH and AF. Previous work has demonstrated only a limited ability to use FH to induce increased player engagement. The results in this study show a significantly more powerful positive effect of FH and AF on engagement.

AltInf showed a significantly increased level of engagement to *NoInf*, with $p < 0.0001$. Additionally, *AltInf* showed a significantly higher level of engagement to *NoFeed,* showing $p = 0.001$ significance. Mean engagement was 4.986, compared to 3.729 and 4.186 in *NoInf* and *NoFeed* respectively. Note how in figure 25, the bar for 'Alt Inf' is notably larger than the bars for No Feed and No Inf, reflecting the increase in engagement. *AltInf* was also significantly more engaging than the other varied scene, *AltFeed,* which reported significance $p = 0.0051$ and mean engagement of 4.143 (again reflected in the graph in figure 25). *AltInf* was therefore more engaging than all other conditions.

Of further significance are results when considering varied conditions contrasted against non varied conditions. When doing so we find that with significance of $p = 0.0016$, varied conditions are significantly more engaging than non varied conditions, with mean engagement of 4.564 in varied conditions compared to a mean of 3.957 in non-varied conditions. Once more, this is best illustrated by figure 26 - note the increase in mean engagement between varied and non varied conditions in the central section.

These results, combined with the results for FH and AF, paint a very clear picture of the role that introducing variety has on the relationship between player FH, AF and engagement. Though FH and AF are increased significantly by the presence of variety, so too is player experience of engagement. In short, variety makes games more likely to cause FH and AF (and therefore frustration), but also makes them more engaging. This was the effect we predicted to exist in the literature review. This effect is present over the entire data set, meaning this result applies to the entire experience and not only a portion of it at the beginning or at the end. This supports the hypothesis that a game which introduces FH/AF from multiple sources will be significantly more engaging than one which utilises only a single source.

7.4 Discussion and Conclusion

The study described in the previous section demonstrated that it was possible for a game to deliberately introduce players to increased FH and AF and yield increased player engagement, the same effect observed as occurring in the initial study reported upon in chapter 4. However, this effect was observed only in the short term, with the positive effects quickly disappearing and being replaced by a distinctly negative effect on engagement. We considered in the aftermath of these results however, that the literature

covered in chapter 2.4 may yet provide a way to produce such an effect over a longer period of time.

The results of this study allow us to make further significant contributions back to the literature we drew upon from chapter 2 of this thesis. This study aimed to investigate whether giving players a varied source of FH/AF and engagement instead of a consistent source of FH/AF and engagement would have significant effects on whether players enjoyed that frustration. In these conditions, we used gameplay elements which had previously been demonstrated to create FH or AF but as part of a varied gameplay sequence in contrast to only using the same gameplay elements repeatedly. Previous literature had suggested that using the same elements repeatedly may result in monotony for players, possibly preventing players from experiencing engagement from FH/AF.

In administering this study, we have taken significant strides toward extending the causal descriptions of FH and AF's effect on engagement expressed in the literature covered previously in this thesis. The results of this study satisfied the aim of investigating whether a varied source of in-game hindrance and therefore FH and AF would be able to induce a prolonged positive change in the player's reported level of engagement. Significant data was found supporting the viewpoint that FH and AF can be used to enhance player experience over extended periods of time. This has significant implications for both games developers and academia, extending existing causal descriptions of how FH and AF affect player engagement, and altering the existing wisdom on how to handle frustration reported by players in games. FH and AF are not something to only eliminate and mitigate, but also something which in the right circumstances can be encouraged and amplified to positive effect.

We note that in this study, a slightly different approach was taken to the two previous interventional studies. Whereas those studies investigated the effects of adding *more* FH/AF to a game relative to a baseline condition, this study investigated the effects of varying the source of FH/AF generating events instead. Instead of each condition facing an increased volume of FH or AF, each condition instead features the same volume but in some conditions (the varied conditions) the nature of the FH/AF is interchanged at a set interval.

In this context the challenge to the view expressed in chapter 2.3 of this thesis, that FH/AF and engagement are opposite factors and that frustration occurs where engagement fails, is twofold. Throughout this thesis FH/AF's effect on engagement has been seen to be inconsistent, with the aforementioned relationship certainly appearing to occur at times, but never at all times. However this study clearly demonstrates that not all FH and AF experienced by players will result in a negative experience. Furthermore we were able to predict and create a situation in which increased levels of frustration accompanied an increased level of player engagement. Rather than being isolated to only a portion of the game, this effect was displayed over the game's entire duration.

An interesting note for this study is that the approach of this study differed from the two previous by modifying the nature of FH and AF in a game rather than simply adding more in each condition. Each varied source of FH and AF is a source of gameplay variation for the player, rather than a direct introduction of new FH/AF as in the previous study in chapter 5. The FH and AF reported by players in this study is therefore an outcome of variation, a tactic employed by designers to make games increasingly engaging. This could suggest that introducing players to engagement strategies

could also result in FH/AF as an outcome in some cases. Further work will be necessary to discern whether introducing FH/AF to players in this manner is consistently wanted or unwanted FH/AF.

Of course, with respect to the viewpoint established in chapter 2.4, that FH/AF and engagement are not opposite factors and that they can instead be deliberately deployed by game developers in the right manner in order to affect positive increases in player engagement, the results from this study are clear. By using variety, we are able to make players report more HF, more AF and more engagement than they did in an equivalent gameplay condition which does not feature variety. In the introduction to this thesis we proposed two research questions. First, if the generation of player FH/AF can enhance a video game experience, increasing rather than decreasing the player's engagement with that game. And second, how and when will this beneficial FH/AF be achieved? This study, and the results of the previous studies show we can now begin to answer these questions. Yes, FH/AF can indeed be used to enhance a video game experience, as demonstrated by this study's results, the previous study's results and the results observed in the initial study. Furthermore, we can begin to see how to create this effect - the beneficial frustration will be achieved when players have a variety of FH/AF generating sources over extended periods of time, and potentially also when encountering very high FH/AF for brief periods.

There remain some limitations to the knowledge provided by this study. Primarily this study tested variation in only a single type of FH and AF. We cannot draw concrete conclusions on whether the same effects will be observed if variation is used with respect to other game genres or game mechanics which are considered to be frustrating in terms of FH and AF to players. Further future work will investigate the extent of these effects in

other game genres in more detail.

In conclusion however, we have investigated and revealed some key challenges to the most common viewpoints taken on frustration's effect on player engagement expressed in the literature. As a result we have identified necessary extensions to the causal descriptions of frustration's effects on player engagement which are raised by that literature. Instead of frustration or FH/AF being the opposite of engagement, it is instead a factor which can be deliberately increased in games in order to give players enhanced enjoyment. Existing causal descriptions do not currently capture this aspect of frustration, or the need to consider FH and AF separately, and are therefore a prime candidate for expansion.

We should note that a separate objective of this research was to consider the utility of these findings to games designers. As described in this discussion section there are clear implications for designers as a result of this study, and the others in this thesis. As a further note however, we add that application of these findings was regularly discussed in design meetings and processes whilst placed at Paperseven, eventually leading to a full-time employed role at the company in order to continue this influence. The design decisions taken in those meetings were a direct result of, and indeed an influence on the work undertaken in this very doctorate. The next chapter begins to unpack the utility of those discussions and these findings in the context of the games Paperseven has made and contributed to during the course of this research, before considering wider potential applications in the final chapter of the thesis.

8 Application to Games Design

A core element of the EngD Doctorate is the industrial placement. Throughout the process of building this research, candidates are placed within an industry partner whose interests align with that of the researcher. The research is therefore undertaken both from an academic interest, and a professional interest. Because of this arrangement, the outcomes of the research produced can be directly fed back into the output of the partner company. For this research, the partner company is *Paperseven*, a small video games developer based in Brighton in the United Kingdom. Though a small company, Paperseven has a significant amount of industry experience among its leads, spanning multiple decades of games industry work. Paperseven's work to date ranges from original properties like *Beef the Bounty Hunter* on mobile platforms, licensed adaptations such as Channel 4's *Made in Chelsea*, and original console and PC games like *Blackwood Crossing*. During the development of these games and subsequent releases, this research has been able to influence various design decisions and responses to testing and metrics data. The relationship is beneficial to the researcher as well; Paperseven's experience allows them to add insight directly and help steer the research toward successful outcomes.

Following the end of the standard period of the EngD partnership, I continued to work with Paperseven, joining the company full time as a Technical Designer, allowing continued and more direct input into the company's output. This chapter outlines examples of ways this research has been influential in Paperseven's work, and outlines ways that Paperseven's work reflects the learning and outcomes of this research. In particular we take a close look at two projects the company has undertaken during and also following this research.

8.1 Blackwood Crossing

Blackwood Crossing is a narrative adventure game released in April 2017 for Windows PC, Xbox One and PlayStation. It focuses on character development and storytelling, interspersed with a selection of puzzles. It aims to engage players through both elements, often alternating between the two at different intervals to help push and pull the player through the story. The puzzle gameplay represents a somewhat unique challenge for this game, since many competitor titles focus mostly on either story or on puzzle gameplay. Games which feature an even mix are less common creating new design challenges for the team to solve.

The puzzles are designed to complement the game's story. Making the two styles of gameplay too disparate was seen as a potential cause of issues for the player, leading to two disjointed elements. A worry was that players playing the story might be annoyed when puzzles came up, distracting them from the story. Those who enjoyed the puzzles might be annoyed when they are taken away from the puzzling. It was important that a balance was found where both types of player could enjoy both types of gameplay. Therefore throughout the game, puzzles influence the story, and the story influences the puzzles. Players use information from the story to solve puzzles, and the puzzles themselves influence the game's story or teach players more about the characters and the game's world. This is inspired in part by research into concepts like satellite mechanics by authors such as Fabricatore[61]. Even when the game asks players to do wildly disparate tasks or new types of gameplay, the influence of knowledge the player already has helps to keep tasks feeling relevant for the player. It also ensures that players never feel too distracted from the style of play that they enjoy the most as recommended by authors such as Andersen et al[7].

Figure 27: A screenshot of Blackwood Crossing

8.1.1 Passenger Matching

This puzzle is an example of a puzzle which reflects the ideas expressed above and influenced by this research. Additionally the use of variety in how the puzzle develops over the rest of the game whenever it is repeated reflects the outcomes of the studies in this research.

The player finds themselves blocked in a train carriage by a barrier. Within the first of these carriages is a pair characters whom the player can interact. The progress the player must 'pair up' the characters by talking to one character, and then the others. There is a correct order the two must be interacted with in order for this happen. The characters are also obviously interactable, sharing the same prompt as all other interactable objects in the game. They are arranged such that upon entering the room, the closest character the player is most likely to interact with is in clear view and closest to the player, and the second character further away. On interaction with the characters, they speak a line of dialogue. Interacting with the characters in the correct order makes their sentences appear to be in response to one another, but in the wrong order their statements do not make sense. Upon

interacting in the correct order, the characters disappear and reappear, but this time sat together, and the barrier is removed. This information helps communicate naturally to the player that the characters are a pair and that there is a correct order to the characters, and that the barrier disappears upon correctly pairing them up. It achieves using information wholly within the world, rather than distracting the player with tutorial prompts or other out-of-world distractions. As covered in the literature review, interruptions from different contexts could cause frustration for the player.

These characters were not initially present in this segment of the game. Instead, the player was placed into a more complex version of the puzzle with three pairs of characters. However, participants of play-tests found the resulting gameplay very high in Feeling of Hindrance and Annoyance at Forestallment, unsure of what to do in order to progress. They explored aimlessly, interacting with items at random hoping to find a solution, until eventually the solution clicked after pairing up one pair correctly. We recognised that the FH/AF was not necessarily the a problem with the design of the puzzle itself, but the information. We introduced the 'tutorial' pair as a result, entering the more complex puzzle immediately after while the learning was fresh in the player's memory. The result was that players were immediately more engaged and behaved with far more intent rather than random interactions with characters. FH/AF was still present in further tests, with players still needing to find the correct partner or remember where characters were, but we judged that the players enjoyed this FH/AF; without it the puzzle would be far too basic. In addition, the lines of dialogue spoken by the characters complement's the game's narrative, filling in character backstories and helping players understand the protagonist's plight. This information is fresh in the player's memory when the game

returns to gameplay consisting mostly of story beats thereafter.

Reflecting the outcomes of the studies in this research, the puzzle also develops each time it is redeployed in the game. At two further points, players will be asked to perform the same matching of characters, however there is a small twist each time they must do so. This develops gameplay in manner similar to those suggested by Lankveld et al and staves off repetition and monotony as suggested by Rauterberg et al. Characters are paired differently, or are hidden in more unique locations. The setting for the puzzle changes, and the dialogue between the characters changes to give new information and reflect the story's progress.

8.1.2 Hot and Cold

Another puzzle which benefited from finding a balance of player FH/AF and engagement was the 'Hot and Cold' puzzle in the game. This puzzle, unlike the Passenger Matching puzzle, appears only once in the game. As a result, the demands for clear information are perhaps even higher than the previous puzzle type, since poor delivery may linger in the player's memory. In this puzzle, players are in an island environment and tasked by another character to repair various objects distributed across this island. To do so they must find a missing part of each object hidden somewhere in the game environment, and return it to the matching location. Though the broken objects are obvious to the player due to their large size, prominent locations in the environment, standout visual design and incidental character dialogue when approaching, the missing items are not due to their small size and hidden locations. The challenge is to locate the items and return them.

The latter part of this task is relatively straight forward, since the missing items are broken-off parts of the larger objects. The player can see the found

item in their hand and will recognise which object it must be from. More difficult is finding the missing item itself. In the game's initial design there was little direction to find the objects. Though hidden, they were not tucked away with deliberate fiendishness, but instead mostly in plain sight but their small size making them harder to locate. It was hoped that players would stumble upon the items as they explored.

This design again turned out to be a source of FH/AF in a negative manner. Players often walked by the items without noticing them due to their small sizes, or not really knowing precisely what they were looking for. There was some discussion about how to resolve this: making the hidden items larger and easier to find would alleviate FH/AF but there was also concern that it would remove the challenge from the puzzle and therefore the engagement (similar to the concept of frustration as a necessary element to create player engagement; removal of frustration outright here would also remove the core of what makes the puzzle engaging to begin with). A compromise solution was used instead which offered various design advantages.

Given the game's story revolving around the relationship between a pair of siblings and these also being the characters involved in the puzzle, in addition to the theme of repairing childhood memories in this segment, a 'Hot and Cold' mechanic was suggested. The characters would play a game of 'hot and cold' in order to locate the objects. The items were then hidden *more* carefully, and now the non player controlled character would, as the player moved around, call out advice to help them locate the items. The character will say 'warmer' 'getting very hot' 'colder' 'red hot!' and so on as the player gets closer and further from the item. This removes the more random wandering behaviour players exhibited but keeps the challenge of

finding the object intact. The player must react to the changing warmth of the messages to work out which way they need to head, or if they have overshot it. Once they are in the 'red hot' zone, they still need to look closely to find the solution.

Again, players were still reporting FH/AF, but became more engaged with the segment after these changes. The FH/AF became a more enjoyable part of the sequence instead, with players reporting that they felt frustrated that they can't find the item in the 'red hot' area but endeavouring to continue because they know they are right on top of the solution. They blame their inability to spot the item on themselves more, instead of the game for not helping them. In addition, the moderately wide range of the red hot area still gives players a sense of satisfaction when they track the item down. If the game told the player exactly where the item was, the satisfaction was likely to be lower; the slight FH/AF was deemed necessary for the segment to work. The use of 'hot and cold' had other benefits as well, similar to those of the first puzzle - it roots the gameplay more closely to the story, helping it feel as though it complements the overall game rather than feeling like a diversion from it.

8.2 Blackwood Crossing Successor

After completing work on Blackwood crossing, Paperseven began work on another game in the same genre and style. It featured a new setting, story, characters and style of puzzle gameplay, which was made more prominent for this game along with exploration elements. The game still required a balance between story and puzzle gameplay, however. This section describes a few mechanics from the game and how their design developed in response to analysis of playtesting results, the responses to which were informed by this

research. The impact of the research on this game was significantly more direct, since at this time my role as a full time Technical Designer had begun. As well as participating in analysis, I was also able to implement responses directly.

8.2.1 Rune & Fracture Puzzles

A key element of the game are of otherworldy intrusions throughout the game's world. These intrusions typically block the player's ability to travel down certain paths in the environment. In order to unblock the path, a puzzle must be completed in order to 'push' the intrusion back out. Across the various iterations of the puzzle design, the general solution steps were consistent:

1. Locate a rune(s) in the vicinity of the intrusion.
2. Locate a point nearby to re-draw the rune(s).
    (a) Each rune consists of a number of 'strokes', for example one rune might be drawn with 'left, right, down' on the player's analogue stick. To input the rune correctly, the player must draw the rune's strokes in the correct order.
    (b) When the player locates a rune for the first time, it is animated instead of a static image, showing the player the correct order of strokes to draw. Once found once, the player can refer to an in-game menu to see the stroke order again.
3. Align an image projected onto a set of shards such that it appears correctly in order to remove the blockage.
    (a) The image in the shards is of the path currently being blocked, but

without the blockage present. For example, if a blockage blocks the front door to a building, the image in the shards is of the house, but *without* the blockage present. The image appears to 'overwrite' the world once it is perfectly aligned - the player does not notice the shards disappearing due to this perfect alignment. The shard image becomes reality and the blockage is gone.

A number of different iterations of this puzzle were used throughout development in order to strike the right balance between player FH/AF and gameplay involvement. The initial iteration of the puzzle featured the runes drawn on floating rocks next to the intrusion. The drawing point would be somewhere nearby with line of sight toward the intrusion - sometimes up a slope or other small obstacle to add a minor challenge to locating the correct position. The shards the player had to align were also very small, and if the player made an error drawing the runes, they had to start from the first rune again. Various issues were identified with this iteration. Many players reported that engagement levels were low in testing but that they liked the idea behind the puzzles. Consensus was that the puzzles were too easy, both in the rune drawing part and the fracture alignment part. FH/AF was very low with the exception of multi-rune puzzles. Players found drawing diagonal strokes difficult with the game often recognising horizontal or vertical strokes instead. Getting this wrong meant starting the rune drawing phase again.

An improved iteration increased player FH/AF slightly in some areas, but also increased engagement. It addressed the FH/AF in rune drawing directly. We made a decision that the rune drawing FH/AF was *not* beneficial FH/AF. These difficulties are a common source of FH/AF in games. Rather than stemming from an attempt to improve player engagement, it

stemmed from difficulty translating player intention to in-game action[121]. This is an example of a time where it is beneficial to understand the difference between a positive and negative frustration. For this next iteration, several changes were made. First, the rune drawing locations were hidden away slightly more off the beaten path in the game world. Second, the shards in the alignment segments were made larger - players were previously solving these puzzles by making gaps between the shards disappear rather than aligning the images, many players did not realise the relation between the shards and the outcome of aligning them. Making the shards larger made this slightly more difficult. Finally, assistance was added to the rune drawing gameplay to detect diagonal strokes more consistently.

Changes to rune drawing made players report reduced FH/AF, while the intended increased challenge in locating drawing spots and shard alignment had less effect than desired. The puzzles generally remained too simple for players, with the main challenge now removed as well. As such, further design iterations were made for these puzzles. Rune drawing and fracture alignment was made more intertwined in response to player feedback who felt the two parts were too disparate. Previously, in a three rune puzzle the player drew three runes from memory, then aligned the shards. We changed the puzzles by breaking up the shard into a number of parts equal to the number of runes. On drawing the first rune of a three rune puzzle, the player must then align one third of the shards. With a smaller image to work from due to the reduced shard number, challenge is increased. After aligning part of the shards they are 'locked in', and the player must remember the next rune. This made players fail inputs more frequently. This was an intended source of FH/AF, but one we also mitigated. Instead of immediately forcing a restart, the player now gets 3 chances at each rune. If they fail 3 times,

they are sent back to the previous rune, rather than having to restart the puzzle.

Player response to these changes were positive and represent a time where making something more frustrating on purpose was beneficial. We introduced errors in players deliberately, but also forgave the errors they made to some extent. Players felt some FH/AF but total failure was rare, and players enjoyed the tension of being on their third and final chance at a rune. Likewise, aligning the shards was now more difficult, but players enjoyed the challenge where previously it barely registered as difficult.

This research was also beneficial in deciding how to deploy these puzzles in the long term. Player appetite for long chains of these puzzles without interruption was deemed to be low, especially as solving these puzzles became more involved. Therefore only 2-3 of these puzzles ever appear in quick succession, before a break allows for other gameplay such as exploration or story development. In addition, we were careful to vary the puzzles as the game progressed, adding satellite mechanics to further challenge players without disrupting too much. These included hiding runes naturally in the environment and using audio cues to locate them, and adding a variety of more and more complex rune shapes to the game. These ensured each time the player encountered a sequence of these puzzles they would be seeing something new.

8.2.2 Bearing Puzzles

Bearing puzzles were a major way variety was added to keep use of runes and intrusions in the game fresh. They re-used some elements of the existing gameplay to ensure players were not totally blind-sided by the change in gameplay, but major twists kept the gameplay fresh for players. At a certain

point in the game, the player needs to drag intrusions into the world instead of pushing them away. They are aided in doing so by another character who is able to scratch runes into the intrusions themselves - there is no need for the player to locate the runes. Since the player does not want to remove the intrusion, the focus shifts to locating where to draw the next set of runes, which is often a significant distance away.

To help the player do so, the intrusion projects a visual effect in a direction which acts as a vector or bearing. The direction shows the straight line direction of the drawing location while its length implies to the player how far away it is. The player must then use a detection device they received earlier in the story in order to narrow down the location. Once close enough, the detector reacts more and more (similar to a hot and cold mechanic) until the rune drawing location appears once close enough. From there, the player draws the runes and the next intrusion appears. The difficulty here manifests in two ways. First, the bearing gives only a straight line - if the drawing location is behind for example, a building, the player must keep their sense of direction while navigating around it. In addition, the player must correctly narrow down the location of the target point. Given the difficulty of doing these steps, we decided against having the player need to align shards in these puzzles since it would detract from the sense of achievement in finding the drawing location.

An additional dimension is added by the possibility of multiple intrusions and bearings being present at once. The above design was created to solve a problem with an initial design where players, upon finding the runes, may see multiple candidate drawing points in the vicinity. A design question was posed: 'how does the player know they are at the right drawing location when they find it'. We realised there was no good answer to this question

because we had already created a trial and error puzzle, and that the solution was to avoid players arriving at the wrong location in the first place. With the bearing and detector mechanic, players will know they are at the wrong location long before hand. For example if the bearing suggests the drawing location is far away and 10 steps later they find a reaction in the detector, they know it must be for a different set of runes and can ignore it. Instead of this being a negative outcome of trial and error, it becomes positive because the player is still aware of the general position of their objective, and has simply gained further information they can exploit later. Though player FH/AF still existed after the introduction of bearing mechanics, engagement shifted positively. We could have reduced FH/AF further by simply giving players a direct waypoint to the rune drawing location, but this would also have been significantly less fun - the frustrating version was more engaging, and we provide just enough help to players to ensure it is not too much. As noted previously, the re-use of mechanics the player is familiar with (runes and drawing them) helps to prevent the new challenge from confusing players, instead feeling more as though it builds on existing knowledge and avoiding potential pit falls from variety.

In addition, both this puzzle type and rune and facture puzzles tie directly into the world - clearing puzzles often rewards story progress, and their existence is directly related to the story. As with Blackwood Crossing, this prevents the types of gameplay from feeling disparate. Characters themselves will often discuss the intrusions and what they mean, while opening paths expands the world the player gets to explore as well.

8.3 Summary

These are just two examples from projects this research has contributed to. As an ongoing part of the Technical Designer role, I have been involved with other projects due to be released in the near future. The learning from this research is applied throughout these projects. Paperseven also contributed to games like *Hot Wheels id*, a toys-to-life and mobile free to play racing game which combines an element of physical play (racing toy cars with chips in on a special track that the app can read the state of in order to set players challenges for track building and racing) and digital play (racing digital cars in the app itself). As part of the metagame team, this research was able to influence the design of the flow between races, and the game's user interface, of which I was responsible for a major portion of implementation. Throughout the months spent on the project we significantly increased the interplay between the game's two halves to make them feel less disparate, and increase the 'playful' feeling of the game's UI. We also made a concerted effort to improve the experience for new users through a series of tutorial messages. These changes were intended to smooth out unintentional frustrations (the user getting lost in the UI for example, or not knowing what buttons do) while keeping more beneficial ones, such as the inherent frustration in losing a difficult challenge or race.

This chapter shows how this research can influence games design on a day to day basis across multiple levels from overarching game design to lower level elements of game mechanics. We can identify potentially problematic areas of FH/AF and mitigate them while also leaving FH/AF sources we judge to be beneficial to players. We are also able to design around these ideas, choosing to add a more strongly FH/AF generating element at places we feel it may be beneficial. This allows us to create games which are

more engaging, through embracing the knowledge that games are likely to always be frustrating to some degree and not assuming that the presence of frustration is inherently a problem in a game's design.

This research can be applied throughout development. In prototyping and design phases, problems can be eliminated before they begin. During testing, this research can help analyse results and decide how to respond to player feedback. There will of course however always be things the designer did not consider. For example, the player behaving in a manner differently to how the designer predicted they would. But through the knowledge generated by this research, the instances of this can be reduced. This research can also apply on any scale of task, from overarching design of gameplay mechanics to specific levels, missions, quests and so on. Both hour to hour and second to second gameplay can be considered in terms of this research.

9 Conclusion

9.1 Research Questions Revisited

In the first chapter of this thesis, we identified two high level research questions that would guide this work:

- Can the generation of player frustration enhance a video game experience i.e. increase rather than decrease a player's engagement with that game?
- If so, when and how can this 'beneficial frustration' be achieved?

In the seven chapters of this thesis that followed, we have described the work undertaken in response to those questions. The approach that we have taken to answering the first research question positively (we have found evidence to support the idea that frustration can be used to generate engagement) and in Chapter 8, the collaboration with games designers through which we have applied our findings.

In the remainder of this chapter, we will draw out the contributions that we have made to knowledge in answering those questions, the scope of the claims that can now be made and the questions that can now be fed back to the research communities from whom we have drawn.

9.2 Review

We started this work by describing the balancing act facing games developers trying to embed obstacles (hindrances) to their games without frustrating players to the extent that they disengage entirely.

We introduced the 'detect and remove' approach to frustration adopted by many researchers and noted the need to extend that approach if support

is to be provided to developers looking to add obstacles to their games as well as those working to remove them.

We identified two interpretations of the overloaded term 'Frustration', namely Feeling of Hindrance (having one's progress blocked) and Annoyance at Forestallment, the subsequent undesirable emotion of annoyance or anger resulting from that blockage. We also noted the interaction between FH and AF with the former often causing the latter.

The remainder of the thesis then investigated, both positive and negative impacts of FH and AF on players engagement with video games.

Our first step in that investigation was to conduct a review of literature yielding insight into the ways in which FH and AF influence player engagement.

We found research focused upon frustration and failure within games, which reported the causal links between FH and AF as well as between frustration and disengagement. We also found complementary research, focused on the characteristics of successful games design, which had implications for our understanding of FH, AF and engagement but did not always unpack those implications.

Our reading of that second body of research led us to believe that FH and AF could be used to create challenge, variety and pacing in video games, three characteristics of successful, engaging games design.

We hypothesised that the causal relationship between FH/AF and challenge/pacing/variety provided an opportunity to games designers managing the balance introduced at the start of this section. As long as the advantages (the engagement associated with challenge, pacing or variety) outweighed the cost (increased frustration (FH and AF)), designers could increase the FH/AF embedded within their games whilst benefiting from increased player

engagement.

In Chapter 4, we reported on the first step that we had taken to investigate this candidate model of the relationship between FH, AF and engagement. More specifically, we reported on an exploratory study, in which we had asked participants to tell us about their experience of playing a well-known, commercial video game described as being both engaging and frustrating. We hypothesised that participants would relate examples of FH and AF being positively correlated with engagement. Our results provided initial support for that hypothesis.

In Chapter 5, we went a step further to investigate the predictive power (or otherwise) of our candidate model. We reported on a second study in which we had asked participants in different conditions of a between-subjects study to report on the effects of introducing increasing levels of FH/AF into their gameplay. We asserted that these injections of FH/AF would provide a challenge and would, therefore result in increased reports of engagement as we increased FA/AF. We did not find evidence to support this hypotheses. We did, however, note that participants reported strong early engagement with our game even in the most challenging condition in the short term.

In Chapter 6, we continued to investigate the idea that FH and AF would be associated with increased engagement when they contributed to challenge, pacing or variety within a video game. More specifically, we proposed different versions of a game, each containing more frequent occurrences of game hindrances which caused FH/AF than the last (pacing). We hypothesised that more frequent the occurrences of FH and AF, the more challenging the game and the higher the level of engagement reported by our participants.

The study yielded two key results: First, participants who encountered FH/AF most frequently (i.e. those encountering injected hindrance at a

higher or faster pace) were significantly more engaged in the first two phases of the study than those encountering injected hindrance only occasionally (low pace). This effect was no longer observable during the third and subsequent phases of the study, suggesting that participants" first reaction to being substantially challenged was positive but that this reaction quickly receded. Second, participants experiencing injected hindrance more frequently (fast pace) reported higher AF than those encountering it less frequently (slow pace) after identical numbers of injected hindrance events.

In Chapter 7, we reported on a study investigating the extent to which variety in the source of the in-game hindrances generating FH/AF experienced by participants would affect their engagement. Our hypothesis was that those with greater variation in the source of FH/AF they encountered would report greater engagement than those experiencing monotonous FH/AF.

We found that introduction of variety once again induced players to feel increased levels of engagement. In other words, participants were more engaged than in conditions in which the source of the FH/AF that they encountered was varied than in conditions in which participants experienced monotonous hindrance. This provided support for the hypothesis that by introducing a variety of FH/AF to our game, we lead to greater engagement.

In Chapter 8, we reported on the ways in which the emerging findings from this work had influenced the design of commercial games at Paperseven, the host company for the Engineering Doctorate underpinning this work. Ongoing discussion with colleagues at Paperseven has both influenced the work reported in this thesis and allowed that work to influence the development of commercial games. We look forward to continuing that interaction going forward and would note and would note the hiring of the Engineering Doctoral student at the heart of this work (the author) to the

full time post of technical designer.

9.3 Scope

There are, of course, limits to the claims that we can make at the end of this work

We would note, for example that the games described in chapters 4, 5, 6 and 7 were developed only to the point that they could be used to support the studies for which they designed. We make no claim that those games have been finished to a commercial standard, nor therefore, that the results reported in previous chapters would have been replicated had our games included professional artwork, quality control and interaction design. We have no reason to believe that the prototypical nature of those games has had a substantial impact on our findings and, as we reported in chapter 8, have interacted with professional games designers throughout this work. Whether or not our findings can be used to guide the design of commercial games beyond those produced at Paperseven is, however an empirical question that can be addressed in future work.

We would also note that the gameplay and in-game interactions considered in our studies were selected in the context of our interest in the small set of phenomena introduced in the first chapter of this thesis. We cannot claim that our results could be reproduced beyond the game segments selected and the limited set of interactions needed to complete those game segments.

Looking more widely, we also need to bound our claims with reference to the particular games investigated and the gaming genres from which they were drawn (i.e. the puzzle game selected in chapters 5 and 7 and platform game in chapter 6). We make no claim that the results reported in this work

would be reproduced if participants were asked to play games from other genres or other games within the genres represented here. The applicability of this work to other genres and other games is an empirical question that can be addressed in future work

Neither can we be sure that the findings of this work would be reproduced beyond the populations from which our participants were drawn. The participants in these studies were drawn from the the audience for Paperseven's games; players, who are young (18-30), British, predominantly male and somewhat familiar with video games. These results may be different for other populations of participants.

More fundamentally still, the reported FH, AF and engagement reported in this thesis arose in the specific circumstances, described above. We can make no claim to have developed a universal model of any one of these phenomena. The research literature describing FH, AF and engagement is both large and rich. We expect the growth in that literature to continue and look forward to making further contributions to that growth.

Additionally, chapter 1.4 of this thesis noted the decision to focus our investigation of how the causal relationship where FH/AF generate increased engagement on potential avenues identified by the exploratory study described in chapter 4. The chapter acknowledged narrative dissatisfaction[134][34], boredom [74], interruption[108] and lack of accessibility[138] as factors which could be worthy of future investigation. Such sources of frustration could reasonably play an accompanying role in the causal explanations developed by this thesis. They may stand as additional ways in which FH/AF can be generated that also positively influence engagement, that were not seen in our initial exploratory study. Alternatively, they may take the role of a 'moderating' element in the relationship. For example player expectations

of narrative fulfilment are known to influence player reception of a game if fulfilled or unfilled[134][34], and such an effect in combination with the causal relationships described in this study, or other external influences may enhance or limit the ability of FH/AF to enhance engagement. As such, the claims made by this thesis pertain directly to frustration (FH and AF) developed through exposure to hindrance, and may not necessarily apply in the same manner to FH and AF developed in other manners.

9.4 Contributions

Those limitations notwithstanding, we have developed contributions to knowledge in the course of this work.

We have, for example, contributed observations of FH and AF being positively correlated to engagement. Both the exploratory study, reported in chapter 4 and the pacing study, reported in chapter 6 for example, gave rise to that observation and the challenges that it raises for the literature introduced chapter 2.

We have also contributed evidence that the interactions between engagement and frustration (FH and AF) are more complex than can be easily explained by the causal descriptions reviewed in chapter 2.3.1. In chapter 4 and chapter 6, we found evidence that engaging segments of gameplay may be frustrating (FH and AF) and that frustrating (FH and AF) segments may be extremely engaging, for example the third phase of gameplay in chapter 4's study which asked players to play through a part of the game *Limbo*.

If frustration (FH and AF) were a reliable indicator of failing player engagement, as suggested by the literature introduced in chapter 2.3.3 we would have expected to have found high reported engagement on the part of our study participants if and only if reported frustration (FH and/or

AF) were low. This was not the case, however. Throughout the four studies conducted in this thesis FH/AF was an ongoing presence regardless of participant engagement level. Though the 100% case in chapter 6's study reported extreme frustration (FH and AF) for example, participants were still able report engagement over considerable stretches of play.

We have also contributed evidence that the interactions between FH and AF are more complex than can be easily explained by the causal descriptions reviewed in 2.3.2. The impact of increasing FH/AF as we did in the studies reported in chapters 5 and 6 was not a clear and consistent rise in participant frustration (FH and AF). We found instead that the injection of hindrance to games could, on occasion leave players' perceived frustration (FH and AF) unchanged. For example, in condition C in chapter 5's study, though participants reported significantly more FH relative to the base condition, the game was not significantly stronger in AF to players.

In addition to the evidence highlighting more complex relationships between FH, AF and engagement than are easily accounted for in the literature, we have also contributed a candidate causal model that accounts for that complexity. More specifically, we have proposed an understanding which predicts FH generating greater engagement when it is used in the development of challenge, appropriate pacing and variety.

In the course of this work, we have found evidence to support that understanding as it relates to variety (reported in chapter 7). We found partial support for that understanding as it relates to pacing (reported in chapter 6) and have not found evidence to support that understanding as it relates to challenge.

In the variety study reported in chapter 7, we were able to use that model as a basis from which to predict an increase in engagement arising the

introduction of heterogeneous hindrances to a video game. More specifically, we were able to vary the sources of in-game hindrance and therefore FH/AF participants encountered. We found evidence to support the idea that those variations led to greater participant engagement with a rudimentary game.

In parallel, in the pacing study reported in chapter 6, we were able to use that model as a basis from which to predict an increase in engagement arising the introduction of additional carefully-paced hindrance to a video game. More specifically, we introduced increasingly frequent in-game hindrance to participant gameplay. In the condition in which players were forced to fail an in-game challenge every time that they encountered it, participants were for a short period at the start of the study, significantly more engaged with the game than their counterparts in a forcing failure only one time in three.

9.4.1 Methodological Reflection

The central objective of this thesis was to provide games designers with guidance about using frustration to enhance player experience in games.

In order to provide this guidance, we sought to develop causal understandings of the way that FH and AF influence player engagement, beyond existing explanations which positioned frustration as a purely negative experience in video games. Our specific objectives expressed in our research questions were to investigate whether the generation of player frustration could enhance player experience of video games, specifically whether the introduction of carefully designed hindrance and frustration could be used to increase rather than decrease player engagement, and if so, in which circumstances that effect could be predicted and developed by well-informed games designers.

The areas in which we drew key insight from existing literature with rel-

evance to these areas are described in chapter 2 and the contributions that our results allowed us to make in return are shown in chapter 9.4, above. Importantly, however, the methodological approaches taken to achieve those results also drew upon the work of previous researchers (see chapter 3) and the experience of adopting those approaches allows us to make additional contributions to future researchers who may wish to adopt a similar approach, choose alternatives as a result of the outcomes presented here, or draw differently on the methodologies considered as a result of the outcomes of this work. This section considers these additional contributions.

In some cases, the design choices that we made whilst adopting a particular approach caused us to identify additional questions that lay beyond the scope of this work, but could be considered in future work. For example, reports from individual participants in chapters 4 to 7 that they considered the games that we had asked them to play to give rise to maximal (or minimal) FH, AF or engagement caused us to ask additional questions about those reports. Our conversations with the professional games design community suggested that scores of 1 (the minimum) or 7 (the maximum) for engagement, AF or FH, were most likely the result of individuals with particularly strong responses to particular passages of gameplay (we did not, for example, have order effects in our results that would suggest players had become so engaged or frustrated that they would not subsequently change their reports). However, exploration of alternative explanations, such as the impact of using a more granular Likert scale and/or considering the responses of individual participants across multiple game categories form an interesting basis for future research.

Furthermore, our design choices for the study reported in chapter 5 caused us to present some participants with very low (i.e. almost zero)

preparatory information and/or feedback during the game developed for the study. We did not however consider the impact of providing participants in different conditions with more granular differences in the preparatory and/or feedback information supplied. For example, no information, a little more, a moderate amount and/or a great deal of information. These considerations lay beyond the scope of this work but practising games designers felt that presenting participants with different amounts of preparatory and feedback information might have given rise to different results than those yielded by our own study – an assertion that can be considered empirically in future research.

Similar questions can be raised with respect to the manipulation of variety and pacing in Chapters 6 and 7: our results showed that careful development of the pacing and variety of hindrance in video games can give rise to increases in player engagement but the boundaries between different conditions (i.e. the level of variety or pacing introduced) may have caused us to overlook further detail about the points at which these effects were observable. Once again, this unpacking of lies beyond the scope of this work but enables us to contribute further questions that might be considered by the research communities from which we drew. These identifications of additional research questions are among the contributions this research makes to future researchers, and need not be rediscovered by those (including ourselves) who have an interest in extending or continuing the work presented in this thesis.

We would also note the subtle but important contributions made by reporting parts of our work that did not yield the results that we had anticipated. For example, the absence of significant results in the study reported in chapter 5, in which we attempted to use modifications to levels of preparatory information and feedback available to players in order to induce

positive changes in player engagement. That study returned no significant support for the hypothesis proposed: that in one or more of the cases with reduced information we would see an increase in player engagement relative to a base situation with the information present.

One interpretation of this lack of significant results is that the causal explanation proposed was invalid, that changing the levels of preparatory information and feedback available to players did not provide insight to games designers who wished to use FH/AF as a means to enhance player engagement. However, we also considered other potential explanations - for example that the research methods used were not appropriate for that particular part of the research. More specifically, we considered the possibility that stopping gameplay in order to ask direct questions of participants could have interfered with the pacing of hindrance the study created. As discussed above, we also considered the possibility that the scale of information removal may have been too extreme relative to the base condition (i.e. that we had removed too much information).

The conclusions reached at the end of chapter 5 remain valid, however. The different information sets presented to participants in different conditions of our study did not give rise to statistically significant differences in the FH, AF or engagement reported by participants. Our questions about the validity of a freeze and question approach when considering video game pacing are however, also valid. Those questions lie beyond the scope of the work presented here but can be considered by future researchers and in future research.

Importantly, however, those concerns about the methods adopted in chapter 5 did not prevent us from contributing to knowledge about the impact of hindrance and FH on player engagement with video games. Un-

derstanding of the methodological approaches adopted in support of that contribution can also be fed back to our research community. In other words, we can report the utility of adopting a mixture of methodologies (the exploratory study reported in chapter 4 and the manipulations reported in chapters 5 through 7) in order to identify phenomena of potential interest to researchers with interest in frustration (in the case of the exploratory study) and causal explanations of those phenomena (the studies which utilised manipulations). More specifically, in order to identify candidate examples of frustration which enhanced player experiences (along with clues as to which gameplay factors may cause such a phenomena to occur) we undertook an exploratory study in which participants were asked to play a game chosen for its potential to generate FH, AF and Engagement and captured self-reports of those variables at key intervals in the game (described in chapter 4). The study demonstrated such an effect can be observed in participants, in addition to clues as to how it can be created.

Future researchers might, therefore, consider adopting a similar approach to initial identification of other characteristics of AF and FH that might give rise to increases in engagement. Subsequently, in order to investigate candidate explanations of the phenomena identified in our exploratory study, we undertook empirical experiments that introduced, varied and removed candidate causes of hindrance designed to induce FH and AF in players while also raising engagement. Adoption of this second approach enabled us to identify key causal explanations of the occasions on which increasing hindrance resulted in increased AF and/or FH, and increased engagement. Once again, future researchers with interests in frustration may wish to adopt similar methodological approaches when moving beyond the identification of phenomena of interest to investigation of causality.

Importantly, in addition to identifying methods that could be employed to both identify candidate phenomena of interest and to investigate the extent to which those phenomena gave rise to greater hindrance and greater engagement, the work presented here also identified additional sources of information on which those methods might be used. As we noted in section 1.4, we drew information from existing literature in this area. That literature identifies other phenomena that lay beyond the scope of this work but may influence the impact of FH and AF on engagement, including but not limited to narrative, boredom and accessibility. However, we also considered other primary sources of information when looking for phenomena that could shed light on the relationship between FH, AF and engagement. One such source was the wealth of player feedback on different video games. We found, for example that online forums in which individual games are discussed provided rich descriptions of both hindrance and its effects such as the points at which players enjoyed frustrating games, found engagement with them to be a negative experience and/or gave up on them.

In the exploratory study reported in chapter 4, we chose to focus on a game reported to be both frustrating and engaging but will return to online forums in preparation for further research in this area. We will, for example, consider the use of natural language analysis on player forums as a basis for identification of further examples of simultaneously frustrating and engaging gameplay. Additionally we will investigate the relationships between FH, AF and engagement in multi-player games and the development of those same experiential variables in games drawn from other genres (e.g. text-only games, augmented reality games and massively-multiplayer online games).

We will also return to conversations with colleagues in the games design

industry, whose comments and challenges were so valuable in the development of this work. In expanding and extending those conversations, we will consider the use of structured conversations, and interviews and focus groups. We are also particularly interested to consider the use of carefully scoped discussions involving both players and developers of games when identifying candidate examples of AF and FH increasing engagement. Interaction with designers is under-investigated as a source of information about frustration and its impact in the literature referred to in chapter 2. Our access to games design practitioners as part of this work has been an important factor in the development of our own contributions and might usefully be considered more often by future researchers in this field.

Importantly however, reflections on the methodological approaches adopted as part of this work and the ways in which those approaches might be used to identify and then develop causal understanding of frustration and engagement lead us back to literature from which we initially drew. In section 3.1, we identified two core approaches to measuring both engagement and frustration. The first of those approaches was to ask study participants directly about the extent to which they felt hindered, frustrated or engaged (through questionnaires and likert scales). The second approach was less direct but less invasive and involved the monitoring of physical proxies for the experience of frustration or engagement – e.g. the force of button presses[167], and analysis of facial expressions made by participants during play[14, 38].

In this work, the identification of occasions in which FH and AH led to engagement caused us to adopt the exploratory study approach, described in chapter 4. The subsequent investigation of causal explanations caused us to adopt the first of the approaches identified in existing literature (dir-

ect questioning of participants as described in chapter 3.1). However, our interest in more granular understanding of pacing and variety (in addition to potential interest in narrative, boredom and accessibility) causes us to reconsider the notion of proxy measures. In particular, investigations of the extent to which additional variance in injections of hindrance did or did not enhance engagement (extending the variety study reported in chapter 7), or whether more granular changes in the timing of injections of hindrance caused similarly linear or non linear changes in player engagement (extending the pacing study reported in chapter 6), might be more easily undertaken if a more granular scale of measurement for frustration and engagement is also used (such as the proxies of facial recognition or button press force, described above).

In this context future researchers may wish to consider the methods adopted and discussed here, not as alternatives to each other but as sequential steps from initial identification of phenomena (exploratory study) through investigation of a causal relationship (direct questioning) to unpacking of detail within that causal explanation (proxy measure). The utility or otherwise of that method sequence will also be investigated in future work.

9.5 Questions For the Research Communities from whose work we have drawn

These results allow us to contribute questions back to the research communities from which we drew at the beginning of this thesis.

First, we can raise questions about the need to extend causal descriptions of the interaction between hindering events in games and frustration introduced in chapter 2.3 We have reported findings that show the commonly asserted phenomenon of frustration (FH and AF) rising with hindering events

in games[28, 30, 84] to hold only in some cases. Our question to the research community with interest in these phenomena is how we account for that inconsistency. We have proposed a model in Chapter 3 that accounts for that inconsistency in some video gaming contexts. The challenge remains to investigate the applicability of our model across a greater range of domains and contexts.

Additionally, as a result of having conducted this work, we can raise questions for the community of researchers introduced in Section 2.3.3, above who propose automated identification of frustration in video games, often with the objective of mitigating or removing that frustration. If frustration (FH and AF) is not a consistent indicator of falling engagement, as we have suggested above, then the removal of that frustration (FH and AF) wherever it is found is, at best, unnecessary and, at worst harmful to the development of gamer engagement with the games that they play. In this case, then, our question to the community is how we extend those causal descriptions to focus only on the cases in which frustration (FH and AF) does indicate falling engagement and enjoyment without interfering in situations in which FH and AF are being used to enhance the gaming experience?

9.6 Relevance for Game Designers

Our interactions with our colleagues at Paperseven and their response to this research suggest that this work makes a practical contribution to the work of games development practitioners in the games development community. This work has already influenced development of the games identified in chapter 7 and will underpin parts of the conversations at Paperseven in the future.

The foremost contribution that this work makes to games designers is

that FH and AF are not always to be avoided in video game development. In the introduction to this thesis, we outlined the metrics and user testing that are commonly used to ascertain how a player feels about a game. This research recommends that it should not be universally concerning to developers that FH or AF is reported by the players of their games.

This research shows that it is possible for a game to be enjoyed in spite of this FH and AF. It may be the case that the game is engaging because of this FH and AF. If the frustration (FH and AF) identified in these situations is removed as a matter of course in these situations, the game may become significantly less enjoyable for players.

Designers should therefore consider frustration (FH and AF) in combination with the player's current engagement level and not in a vacuum. The developer's goal should not be to immediately to eliminate the source of frustration (FH and AF). As shown by the results of the studies in this thesis, it is possible that frustration (FH and AF) could be made to have a positive impact on player engagement with a commercial title, as a result of principled modifications to the game. Adjustments in pursuit of challenge, pacing and variety rather than a wholesale redesign could shift the player experience in a positive direction.

Likewise, developers should be aware that although frustration (FH and AF) can damage player engagement with a game engagement, they may also be the reason that a particular title is going to succeed. If frustration (FH and AF) is high and engagement is also high, developers should not take this as a sign that something is wrong. Instead, it should be considered whether the FH and AF identified are in fact being used to generate challenge, pacing or variety and may, in fact be the reason the players are so engaged. Developers should however also be wary of maintaining this level

of frustration (FH and AF) for too long, as it may become monotonous or reach a point where it is no longer enjoyable - this research has not considered the effects of extremely prolonged exposure to frustrating (FH and AF) situations, however prior research emphasises the need for moments of relaxation in games as well as intensity[63].

Additionally, if frustration (FH and AF) and engagement are low, developers should consider the possibility of adding frustration (FH and AF) to enhance gameplay in their designs. In the process of designing a segment of gameplay, frustration (FH and AF) seems unavoidable, designers should also consider whether the frustration (FH and AF) might also be increasing variety felt by the player. Frustration (FH and AF) should not be avoided by developers as a matter of course, and should be considered as something add deliberately at some points.

9.7 Relevance to a Wider Community of Human Computer Interaction Researchers

Whilst the work reported in this thesis focuses primarily on the development and enjoyment of video games, it has implications for a wider community of human computer interaction researchers with an interest in user frustration and engagement with software. The literature introduced in chapter 2 highlights the extent to which researchers in that wide community have considered FH and AF to be consistently negative influences on human computer interaction (HCI).

At the very least, this thesis raises questions about the potential nature and utility of FH, AF and engagement for researchers with interests in gamification[50, 51, 75, 117]. Those same questions can, however, also be raised around the utility or otherwise of principled FH or AF of office software,

transport systems and educational software. Those questions can be taken up in future research.

9.8 Conclusion

In conclusion, this work has made contributions to the knowledge by extending understanding of FH and AF and their impact on gamer engagement with the games that they play. This work has also contributed to the knowledge of the games development community through the integration of this work into Paperseven's productions, and work beyond this thesis. It is our hope that dissemination of these contributions will take place through the hoped-for publication of this thesis and publications arising from the questions identified earlier in this chapter.

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Appendix A

This appendix contains information relating to ethical considerations in the studies conducted in this thesis.

13 Point Ethics Checklists

UNIVERSITY OF BATH

Department of Computer Science

13-POINT ETHICS CHECK LIST

This document describes the 13 issues that need to be considered carefully before students or staff involve other people ("participants") for the collection of information as part of their project or research.

1. *Have you prepared a briefing script for volunteers?*

A briefing script has been prepared and will be read to each participant before starting, with an opportunity to ask questions before starting. It explains what participants will be asked to do, some controls for the game and briefs them on the questions and data that will be collected.

2. *Will the participants be using any non-standard hardware?*

No non standard hardware is used. Users interact with a standard computer using a standard gamepad.

3. *Is there any intentional deception of the participants?*

Participants are not deceived as part of the experiment. All relevant information needed is provided in the briefing.

4. *How will participants voluntarily give consent?*

Each participant will be asked to confirm they are happy to participate following the briefing.

5. *Will the participants be exposed to any risks greater than those encountered in their normal work life?*

There is no risk of harm in this study. Participants simply play a video game which is available for purchase using standard means.

6. *Are you offering any incentive to the participants?*

No incentive is offered for this study.

7. *Are any of your participants under the age of 16?*

No participants will be under the age of 16 for this study.

8. *Do any of your participants have an impairment that will limit their understanding or communication?*

All participants are required to understand this studies requirements and be able to use a gamepad.

9. *Are you in a position of authority or influence over any of your participants?*

I am not in a position of authority over any of the participants of this study. Participants are students at the university and I am not involved with teaching, supervision or otherwise of these students.

10. *Will the participants be informed that they could withdraw at any time?*

Students are told during the introductory briefing they may quit at any time.

11. *Will the participants be informed of your contact details?*

During debrief, participants are given the details of the researcher for further contact.

12. *Will participants be de-briefed?*

The purpose of the study is explained to participants following participation and given the opportunity to questions.

13. *Will the data collected from the participants be stored in an anonymous form?*

All data collected from the questions is stored only as collections of numerical data from likert scale questions. No personally identifiable information is collected, and all data is stored securely.

NAME: Adam Boulton

SUPERVISOR (*IF APPLICABLE):* Rachid Hourizi

SECOND READER (IF APPLICABLE): _____

PROJECT TITLE: _____

DATE: February 2014

UNIVERSITY OF BATH

Department of Computer Science

13-POINT ETHICS CHECK LIST

This document describes the 13 issues that need to be considered carefully before students or staff involve other people ("participants") for the collection of information as part of their project or research.

1. *Have you prepared a briefing script for volunteers?*

Participants are sent a briefing script which they are asked to read before starting the study; the download link to the game is contained at the end of the script. The script explains what participants will be asked to do, some controls for the game and briefs them on the questions and data that will be collected.

2. *Will the participants be using any non-standard hardware?*

No non standard hardware is used. Users interact with their own personal standard computer using their own mouse and keyboard.

3. *Is there any intentional deception of the participants?*

Participants are not deceived as part of the experiment. All relevant information needed is provided in the briefing.

4. *How will participants voluntarily give consent?*

Each participant is asked to confirm they are happy to participate following reading the briefing before downloading the game.

5. *Will the participants be exposed to any risks greater than those encountered in their normal work life?*

There is no risk of harm in this study. Participants simply play a video game which contains no unusual gameplay elements.

6. *Are you offering any incentive to the participants?*

No incentive is offered for this study.

7. *Are any of your participants under the age of 16?*

No participants will be under the age of 16 for this study.

8. *Do any of your participants have an impairment that will limit their understanding or communication?*

All participants are required to understand this studies requirements and be able to use their input method comfortably.

9. *Are you in a position of authority or influence over any of your participants?*

I am not in a position of authority over any of the participants of this study. Most participants are students at the university and I am not involved with teaching, supervision or otherwise of these students. Other participants are friends, family and colleagues whom I am again in no position of authority or influence over.

10. *Will the participants be informed that they could withdraw at any time?*

Students are told during the introductory briefing they may quit at any time.

11. *Will the participants be informed of your contact details?*

Participants are aware of the investigator's contact details at all points during the study due it being remotely administered.

12. *Will participants be de-briefed?*

Participants are sent a debriefing script on confirmation of having finished the study.

13. *Will the data collected from the participants be stored in an anonymous form?*

All data collected from the questions is stored only as collections of numerical data from likert scale questions. No personally identifiable information is collected, and all data is stored securely.

NAME: Adam Boulton

SUPERVISOR (*IF APPLICABLE):* Rachid Hourizi

SECOND READER (IF APPLICABLE): _____

PROJECT TITLE: _____

DATE: December 2016

Participant Briefing Scripts

The script used to brief participants was bullet point based for study 1 and is reproduced below. Study 2, 3 and 4 provided a .txt readme file for participants to read, and each is reproduced below.

Study 1

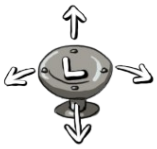
- You're going to play through a portion of the game, divided into 6 smaller portions
- After each portion of the game, I'll stop and ask you to answer a few questions on a questionnaire before continuing. The question data collected will be kept anonymous.
- In the interests of time, each section has a time limit. Do not worry if you don't make it through a section. We will do the questionnaire, then move on. Note that the question order will not always be the same.
- It will take up to an hour for this study to finish.
- You are free to stop playing and end the study whenever you wish.
- Please confirm you have not played this game before.
- Please confirm you do not suffer from arachnophobia.
- There is a sheet with the game's controls on it here. Please read it and let me know if you have questions. It will be available for reference throughout the study (show sheet to participant)
- While the game is being played I will not able to offer you help with any of the puzzles.

- You are free to quit at any time and the data collected from the questionnaire will not be used.
- I'll show you the questions in advance now - please familiarise yourself with them.
- Any questions?
- Are you happy to continue with the study? (Sign consent form and confirm over age of 16)

Controls Sheet

GAME CONTROLS

BASIC CONTROLS



Use the **LEFT THUMBSTICK** to move your character about

Press the **A BUTTON** to jump.
Hold down the button to jump further and grab a hold of ledges

Press the **X BUTTON** to grab hold of objects on the ground.
Move using the **LEFT THUMBSTICK** while pressing **X** to push/pull objects

Press the **START BUTTON** when asked to pause the game.

ADDITIONAL CONTROLS

When **CLIMBING A ROPE**, use up and down on the **LEFT THUMBSTICK** to ascend or descend the rope

When **CLIMBING A ROPE**, use left and right on the **LEFT THUMBSTICK** to swing left or right. Repeatedly swinging one way then the other will help you swing further.

When **CLIMBING A ROPE**, press the **A BUTTON** to jump off in the direction you press on the **LEFT THUMBSTICK**

NOTES

- You will jump further if you take a run up, and hold down the jump button in the air!
- If you are hanging off a ledge, press **A** to climb up, or push down on the **LEFT THUMBSTICK** to drop down
- You will never need to backtrack to a previous section of the game in order to progress
- Your character will hold his hands out in front of him if he is able to grab hold of an object

Sample Consent Form

CONSENT FORM

I confirm that I have received the briefing for this study from its conductor. I have had the opportunity to ask questions and understand that this study will collect anonymous numerical data during its course. I understand that my participation is voluntary and that I am free to withdraw at any time. I confirm that I am over the age of 16 and consent to participation in this study.

Participant Name: _____

Date: _____

Signature: _____

Study 2

This is the text of the readme file provided to participants before they were able to download and play the game for the study.

>>> STUDY README <<<

Thanks for participating in this study! There are no instructions in-game, so please read these instructions thoroughly before launching the game.

This study should take around 20 minutes for you to complete. It ends as soon as you have played for 20 minutes (not including time spent answering questions) and the should automatically close itself once you have finished (a screen will be displayed thanking you for participation before doing so), so please do not be alarmed if it does close itself.

A link to download the game file is provided at the bottom of this document after the instructions. Again, please read the instructions thoroughly first.

>>> ABOUT THE STUDY <<<

In this study, you will play a puzzle game from a first-person perspective. Your objective is to move from room to room completing puzzles, which will unlock the doors to continue progress. Every two minutes, the game will automatically pause to ask you a set of questions. Please only play the game once. You are free to stop playing the game and study at any time. If you do choose to stop, please do not re-attempt the study at a later time. If you wish to fully complete the study, please play until the time limit has elapsed and the game has closed itself.

Please note that this study involves matching colours. If you are colour-blind, please do not participate in this study.

>>> DATA COLLECTION <<<

After each two minutes you will be asked a set of questions. These will be questions asking about your experience with the game, on a scale of 1-7 from strongly disagree to strongly agree for each question.

- I am enjoying the game
- I am finding the game frustrating
- I feel the game actively hinders me from progressing

Please take the time to answer these questions as accurately as possible before continuing the game.

The data collected from these questions is the *only* data collected by the game, which is sent automatically and anonymously once you have finished. Remember you are free to stop playing the game and study at any time. No data will be collected unless the study is completed.

>>> CONTROLS <<<

The game only supports keyboard and mouse input. Given the nature of the game, it is recommended you use a physical mouse over a touchpad. Please do not participate if you do not have access to a suitable mouse and keyboard or are uncomfortable with the control schema.

Use the W, S, A and D keys to move forward, backward, left and right respectively. Use the mouse to look around. Press E to interact with puzzles when you are close to them and the prompt appears. Once in a puzzle, click the tiles to change their colour or the red large button to check your solution.

>>> GAME LINK AND TECH NOTES <<<

The nature of data collection relies upon the game client being able to send question response data on completion. Please ensure you have an active internet connection while playing.

Once you have finished playing, please send me a message on the medium by which I originally sent you this file, or to adam@paperseven.com letting me know you've finished so that you can be debriefed as to the purpose of the study.

Download the game here:

<study download link no longer valid>

Before starting, please message me at adam@paperseven.com acknowledging your consent for participating in this study and that you are over the age of 16.

Please UNZIP the file (in windows explorer, open the file and drag the contents onto your desktop or into a new folder) before playing or it will not work correctly!

Study 3

This is the text of the readme file provided to participants before they were able to download and play the game for the study.

>>> STUDY README <<<

Thanks for participating in this study! There are limited instructions in-game, so please read these instructions thoroughly before launching the game.

This study should take somewhere between 5-10 minutes for you to complete. It ends as soon as you reach the end of the game and the should automatically close itself once you have finished (a screen will be displayed thanking you for participation before doing so), so please do not be alarmed if it does close itself.

A link to download the game file is provided at the bottom of this document after the instructions. Again, please read the instructions thoroughly first.

>>> ABOUT THE STUDY <<<

In this study, you will play a jumping/platforming game from a first-person perspective. Your objective is to move through the game world following the path, jumping over the gaps as you approach them. Aim to successfully jump over as many gaps as possible. Failing a jump will move you to the next one automatically. Please only play the game once. You are free to stop playing the game and study at any time. If you do choose to stop, please do not re-attempt the study at a later time.

>>> **DATA COLLECTION** <<<

After every 6 obstacles, you will be asked a few simple questions. These will be questions asking about your experience with the game, on a scale of 1-7 from strongly disagree to strongly agree for each question.

- I am enjoying the game
- I am finding the game frustrating
- I feel the game actively hinders me from progressing

Please take the time to answer these questions as accurately as possible before continuing the game.

The data collected from these questions is the *only* data collected by the game, which is sent automatically and anonymously once you have finished. Remember you are free to stop playing the game and study at any time. No data will be collected unless the study is completed.

>>> **CONTROLS** <<<

The game only supports keyboard and mouse input, or using an xinput gamepad. Given the nature of the game, it is recommended you use a physical mouse over a touchpad. Please do not participate if you do not have access to a suitable mouse and keyboard or game controller, or are uncomfortable with the control schema.

For Mouse and Keyboard Users, use the W, S, A and D keys to move forward, backward, left and right respectively. Use the mouse to look around. Press the space bar to jump.

For Gamepad users, use the left analogue stick to move, and the right analogue stick to look around. Use button1 to jump (this is typically the A

button on an Xbox gamepad or X button on PlayStation gamepad). If you have a keyboard connected, use the = and - keys to increase or decrease the look sensitivity.

>>> GAME LINK AND TECH NOTES <<<

The nature of data collection relies upon the game client being able to send question response data on completion. Please ensure you have an active internet connection while playing.

Once you have finished playing, please send me a message on the medium by which I originally sent you this file, or to adam@paperseven.com letting me know you've finished so that you can be debriefed as to the purpose of the study.

Download the game here:

<study download link no longer valid>

Before starting, please message me at adam@paperseven.com acknowledging your consent for participating in this study and that you are over the age of 16.

Please UNZIP the file (in windows explorer, open the file and drag the contents onto your desktop or into a new folder) before playing or it will not work correctly!

Study 4

This is the text of the readme file provided to participants before they were able to download and play the game for the study.

>>> STUDY README <<<

Thanks for participating in this study! There are no instructions in-game, so please read these instructions thoroughly before launching the game.

This study should take somewhere between 15-30 minutes for you to complete. It ends as soon as you reach the end of the game and the should automatically close itself once you have finished (a screen will be displayed thanking you for participation before doing so), so please do not be alarmed if it does close itself.

A link to download the game file is provided at the bottom of this document after the instructions. Again, please read the instructions thoroughly first.

>>> ABOUT THE STUDY <<<

In this study, you will play a puzzle game from a first-person perspective. Your objective is to move from room to room completing puzzles, which will unlock the door to the next room. Each room contains 2 puzzles. There are 7 rooms with puzzles total, each containing 2 puzzles, so there is a total of 14 puzzles. Please only play the game once. You are free to stop playing the game and study at any time. If you do choose to stop, please do not re-attempt the study at a later time.

If you are colour-blind, please do not participate in this study.

>>> DATA COLLECTION <<<

After you solve each room and move to the next, you will be asked a few simple questions. These will be questions asking about your experience with the game, on a scale of 1-7 from strongly disagree to strongly agree for each question.

- I am enjoying the game
- I am finding the game frustrating
- I feel the game actively hinders me from progressing

Please take the time to answer these questions as accurately as possible before continuing the game.

The data collected from these questions is the *only* data collected by the game, which is sent automatically and anonymously once you have finished. Remember you are free to stop playing the game and study at any time. No data will be collected unless the study is completed.

>>> CONTROLS <<<

The game only supports keyboard and mouse input. Given the nature of the game, it is recommended you use a physical mouse over a touchpad. Please do not participate if you do not have access to a suitable mouse and keyboard or are uncomfortable with the control schema..

Use the W, S, A and D keys to move forward, backward, left and right respectively. Use the mouse to look around. Press E to interact with puzzles when you are close to them and the prompt appears. Once in a puzzle, click the tiles to change their colour or the red large button to check your solution.

>>> GAME LINK AND TECH NOTES <<<

The nature of data collection relies upon the game client being able to send question response data on completion. Please ensure you have an active internet connection while playing.

Once you have finished playing, please send me a message on the medium by which I originally sent you this file, or to adam@paperseven.com letting

me know you've finished so that you can be debriefed as to the purpose of the study.

Download the game here:

<study download link no longer valid>

Before starting, please message me at adam@paperseven.com acknowledging your consent for participating in this study and that you are over the age of 16.

Please UNZIP the file (in windows explorer, open the file and drag the contents onto your desktop or into a new folder) before playing or it will not work correctly!

APPENDIX B

Appendix B contains raw data from each of the 4 studies conducted in this research.

Raw Data - Study 1

The following 3 tables contain the raw results data for study 1, reported in chapter 4 of the main thesis.

Table 6: Participant Scores for Engagement

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
P1	5	5	5	5	6	5
P2	5	4	4	4	4	4
P3	6	6	7	7	7	7
P4	6	7	7	7	7	7
P5	7	7	7	7	7	7
P6	5	4	5	5	5	4
P7	7	7	7	7	7	7
P8	5	5	6	6	6	6
P9	5	5	4	5	6	6
P10	6	6	6	6	6	6
P11	6	7	6	6	7	7
P12	4	1	1	1	1	1
P13	6	6	6	6	6	6
P14	6	7	7	7	6	7
P15	5	5	6	6	4	4
P16	7	7	6	7	6	7
P17	7	6	6	6	6	7

Table 7: Participant Scores for Annoyance at Forestallment

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
P1	2	1	1	1	2	2
P2	2	2	2	2	4	3
P3	2	1	2	1	1	1
P4	3	1	6	2	2	1
P5	2	1	1	1	1	1
P6	2	2	2	3	2	2
P7	1	1	1	1	1	2
P8	4	2	1	2	1	2
P9	3	3	4	3	2	3
P10	2	2	3	3	4	3
P11	4	2	3	2	2	2
P12	4	2	2	4	2	3
P13	1	2	4	6	4	3
P14	4	1	2	2	3	2
P15	2	5	4	4	5	5
P16	1	1	1	1	3	3
P17	3	4	4	2	3	2

Table 8: Participant Scores for Feeling of Hindrance

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
P1	2	1	2	1	1	1
P2	1	3	3	2	2	3
P3	3	1	2	1	1	1
P4	7	3	7	6	7	6
P5	2	3	7	1	5	3
P6	3	3	5	5	3	3
P7	6	7	7	5	7	7
P8	3	3	2	2	5	2
P9	4	3	4	3	2	2
P10	4	2	6	4	6	4
P11	1	1	2	1	1	1
P12	2	2	2	2	2	2
P13	3	3	5	5	5	4
P14	1	6	6	2	6	3
P15	4	6	5	5	5	5
P16	1	1	1	1	1	1
P17	2	5	5	2	2	2

Raw Data - Study 2

The following 6 tables contain the raw results data for study 2, reported in chapter 5 of the main thesis.

Raw Data - Study 3

The following 3 tables contain the raw results data for study 3, reported in chapter 6 of the main thesis.

Raw Data - Study 4

The following 3 tables contain the raw results data for study 4, reported in chapter 7 of the main thesis.

Table 9: Participant results for Engagement in conditions A and B

		Engagement									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
A	P1	6	5	4	4	5	5	6	4	4	5
A	P2	6	6	5	6	5	7	6	7	7	7
A	P3	3	2	2	2	5	3	5	4	3	2
A	P4	5	6	6	6	6	6	6	2	3	3
A	P5	3	2	2	2	3	4	3	4	6	6
A	P6	5	6	6	6	6	6	6	2	3	3
A	P7	4	5	3	2	2	2	1	1	1	1
A	P8	5	6	6	6	6	5	6	7	6	6
A	P9	6	6	6	7	6	6	6	7	5	5
A	P10	5	6	5	5	5	5	5	5	5	5
A	P11	4	5	5	5	6	5	6	6	6	6
B	P12	6	7	7	7	7	7	7	7	7	7
B	P13	3	3	5	3	3	3	3	3	3	3
B	P14	3	3	3	3	3	2	2	3	3	2
B	P15	6	6	4	4	3	5	5	5	4	3
B	P16	3	5	6	7	7	7	7	7	5	3
B	P17	2	4	4	4	3	3	2	2	2	3
B	P18	5	5	4	3	2	2	2	1	1	1
B	P19	3	4	6	4	5	2	1	1	6	5
B	P20	5	5	4	5	4	6	5	5	5	5
B	P21	5	4	3	3	3	5	5	3	5	6
B	P22	6	7	7	7	7	7	7	7	7	7

Table 10: Participant results for Engagement in conditions C and D

		Engagement									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
C	P23	5	4	3	2	5	3	3	3	2	2
C	P24	5	4	1	1	1	1	1	1	1	1
C	P25	5	6	5	5	5	5	5	5	5	5
C	P26	5	5	6	5	5	6	6	6	6	6
C	P27	5	5	5	5	6	6	6	6	7	6
C	P28	6	6	6	5	5	6	6	6	5	5
C	P29	3	5	5	4	5	5	5	5	5	5
C	P30	5	6	6	6	6	6	5	5	5	2
C	P31	4	2	6	6	6	5	4	4	3	4
C	P32	5	5	5	6	6	7	7	7	7	6
C	P33	6	5	5	5	6	5	6	4	6	5
D	P34	5	4	3	3	2	3	2	3	2	2
D	P35	7	7	7	3	1	1	1	1	1	1
D	P36	4	5	5	4	3	3	1	1	1	1
D	P37	5	5	5	3	3	3	2	2	2	1
D	P38	4	3	2	4	4	4	4	7	2	1
D	P39	4	4	2	2	1	1	1	1	1	1
D	P40	3	2	1	1	1	1	1	1	1	1
D	P41	6	4	4	2	1	1	1	1	1	1
D	P42	4	1	1	1	1	1	1	1	1	1
D	P43	6	5	4	4	3	1	1	1	1	1
D	P44	6	4	4	3	3	2	1	1	1	1

Table 11: Participant Feeling of Hindrance Scores in conditions A and B

		Feeling of Hindrance									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
A	P1	3	3	3	5	3	3	2	3	3	3
A	P2	3	4	2	2	3	2	1	1	1	1
A	P3	5	4	5	5	4	5	5	6	5	5
A	P4	1	1	1	1	1	1	1	1	1	1
A	P5	3	4	3	3	2	1	2	1	2	1
A	P6	1	1	1	1	1	1	1	1	1	1
A	P7	3	3	4	3	2	3	7	7	7	7
A	P8	1	1	3	3	2	2	1	1	1	1
A	P9	1	2	4	4	4	2	4	3	1	1
A	P10	3	5	5	5	5	3	6	5	5	5
A	P11	3	1	1	1	3	3	3	2	2	2
B	P12	2	1	7	1	1	1	1	1	1	3
B	P13	5	5	5	5	5	5	5	5	5	5
B	P14	5	6	6	6	6	6	6	6	6	6
B	P15	5	4	3	3	3	4	3	4	4	3
B	P16	7	3	2	2	1	1	1	5	7	7
B	P17	4	1	1	1	1	1	1	2	2	5
B	P18	3	2	3	3	3	3	3	3	5	5
B	P19	1	1	1	1	1	1	1	1	1	4
B	P20	5	6	6	2	2	2	1	1	1	2
B	P21	4	5	6	6	5	5	4	6	5	4
B	P22	2	1	1	1	1	1	1	1	1	1

Table 12: Participant Feeling of Hindrance Scores in conditions C and D

		Feeling of Hindrance									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
C	P23	4	4	4	6	4	4	4	4	4	4
C	P24	6	7	7	7	7	7	7	7	7	7
C	P25	2	2	5	5	5	5	5	5	6	7
C	P26	2	3	2	3	2	5	2	2	2	3
C	P27	4	3	3	3	3	4	3	4	4	4
C	P28	3	3	2	3	3	3	5	3	3	3
C	P29	2	2	2	3	1	2	3	3	3	3
C	P30	1	1	1	1	1	1	1	1	1	1
C	P31	4	5	3	3	4	4	4	4	3	3
C	P32	5	5	3	2	2	1	3	2	3	3
C	P33	2	2	3	3	4	4	3	5	2	3
D	P34	5	5	6	5	5	6	6	6	6	7
D	P35	1	5	7	7	7	7	7	7	7	7
D	P36	6	6	7	6	7	7	7	7	7	7
D	P37	5	6	5	6	7	7	7	7	7	7
D	P38	4	4	4	4	4	4	4	1	4	7
D	P39	6	5	6	7	7	7	7	7	7	7
D	P40	4	6	7	7	7	7	7	7	7	7
D	P41	4	5	6	7	7	7	7	7	7	7
D	P42	4	7	7	7	7	7	7	7	1	7
D	P43	3	5	6	7	7	7	7	7	7	7
D	P44	2	3	4	5	5	6	6	7	7	7

Table 13: Participant Annoyance at Forestallment Scores in conditions A and B

		Annoyance at Forestallment									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
A	P1	2	2	3	4	3	3	2	3	4	2
A	P2	3	3	3	2	3	2	2	1	1	1
A	P3	6	5	4	6	4	5	5	5	5	5
A	P4	5	1	1	1	1	1	1	2	3	3
A	P5	3	5	5	6	5	5	5	4	6	3
A	P6	5	1	1	1	1	1	1	2	3	3
A	P7	3	5	5	3	1	1	5	6	7	7
A	P8	1	2	2	2	3	3	2	2	1	1
A	P9	4	5	3	5	5	4	5	4	4	4
A	P10	5	5	3	3	5	5	5	5	5	5
A	P11	2	2	1	1	1	2	2	1	1	2
B	P12	1	1	1	1	1	1	1	1	1	3
B	P13	5	5	5	5	5	5	5	5	5	5
B	P14	3	3	5	6	6	6	6	6	6	6
B	P15	6	6	3	5	3	3	4	4	4	3
B	P16	7	3	3	2	2	1	1	1	6	7
B	P17	4	3	2	1	1	1	1	2	2	5
B	P18	3	3	3	3	3	4	5	5	6	6
B	P19	3	2	1	1	1	1	1	1	1	2
B	P20	6	5	7	3	3	3	2	2	2	3
B	P21	5	5	6	5	6	4	3	3	3	3
B	P22	3	2	1	1	1	1	1	1	1	1

Table 14: Participant Annoyance at Forestallment Scores in conditions C and D

		Annoyance at Forestallment									
Condition	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
C	P23	5	6	6	2	6	5	6	6	6	6
C	P24	4	7	7	7	7	7	7	7	7	7
C	P25	3	2	4	4	5	5	5	5	4	5
C	P26	3	3	2	3	3	2	2	2	2	3
C	P27	5	3	3	3	3	2	1	2	2	3
C	P28	3	3	2	2	2	2	2	3	3	2
C	P29	1	2	2	3	2	1	1	1	1	1
C	P30	2	1	1	3	1	1	2	1	1	6
C	P31	4	6	5	5	4	5	3	3	3	3
C	P32	5	5	4	2	2	2	2	1	2	3
C	P33	3	3	3	4	4	4	3	3	3	3
D	P34	5	6	6	7	7	7	6	7	7	7
D	P35	3	7	5	7	7	7	7	7	7	7
D	P36	5	5	6	6	7	7	7	7	7	7
D	P37	2	2	4	5	6	6	6	7	7	7
D	P38	4	5	4	4	4	4	4	1	6	7
D	P39	5	5	6	7	7	7	7	7	7	7
D	P40	5	6	7	7	7	7	7	7	7	7
D	P41	5	5	6	7	7	7	7	7	7	7
D	P42	7	7	7	7	7	7	7	1	7	7
D	P43	3	5	5	6	7	7	7	7	7	7
D	P44	2	3	4	4	5	6	6	7	7	7

Table 15: Participant results for Engagement per condition

		Engagement							
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
0%	P1	6	6	7	6	5	5	5	5
0%	P2	2	4	4	4	4	4	4	5
0%	P3	5	7	7	7	6	5	5	6
0%	P4	3	5	3	2	5	5	5	4
0%	P5	3	3	4	4	4	5	3	3
0%	P6	6	7	7	7	7	7	7	7
0%	P7	1	4	5	4	3	4	5	7
0%	P8	4	5	5	5	4	5	4	4
0%	P9	4	5	5	6	7	7	7	7
0%	P10	4	2	3	2	3	3	4	4
33%	P11	3	2	5	3	4	3	2	2
33%	P12	3	4	5	5	5	4	5	5
33%	P13	4	5	5	5	5	5	5	5
33%	P14	3	3	3	3	3	5	4	3
33%	P15	2	5	5	3	5	6	6	6
33%	P16	5	5	4	3	3	4	3	3
33%	P17	1	2	3	3	3	2	2	2
33%	P18	4	3	2	3	2	3	3	2
33%	P19	3	3	4	4	3	3	3	2
33%	P20	2	2	3	2	2	2	1	3
66%	P21	2	2	1	1	1	1	1	1
66%	P22	5	6	5	5	4	4	5	5
66%	P23	5	6	5	6	5	6	4	5
66%	P24	5	5	4	4	2	2	1	2
66%	P25	4	1	1	1	1	1	1	1
66%	P26	4	4	4	3	3	3	3	3
66%	P27	5	5	5	3	2	3	2	2
66%	P28	4	5	7	6	7	7	6	7
66%	P29	1	1	1	1	1	1	1	1
66%	P30	2	5	3	3	3	3	7	2
100%	P31	6	5	3	3	2	3	4	3
100%	P32	3	4	3	1	3	1	1	1
100%	P33	1	7	7	7	7	7	7	7
100%	P34	5	3	5	5	5	4	5	5
100%	P35	1	1	1	1	1	1	1	1
100%	P36	6	5	3	2	1	1	1	1
100%	P37	4	3	2	2	2	2	2	1
100%	P38	4	4	5	4	1	1	1	1
100%	P39	6	6	5	5	7	5	6	7
100%	P40	4	3	2	1	1	1	1	1

Table 16: Participant results for Annoyance at Forestallment per condition

		Annoyance at Forestallment							
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
0%	P1	3	2	2	1	1	2	2	1
0%	P2	3	3	2	2	2	2	2	2
0%	P3	2	2	1	1	1	1	1	1
0%	P4	4	3	2	2	4	5	3	3
0%	P5	3	4	5	5	5	5	4	4
0%	P6	2	1	1	1	1	1	1	1
0%	P7	7	7	7	6	7	5	5	6
0%	P8	4	4	4	4	4	2	3	1
0%	P9	5	4	4	4	4	2	3	5
0%	P10	2	2	2	1	1	1	1	1
33%	P11	2	5	4	3	5	4	4	5
33%	P12	3	2	2	2	3	4	3	3
33%	P13	4	4	4	4	4	4	4	4
33%	P14	4	4	4	2	3	1	4	4
33%	P15	6	3	6	6	5	1	2	3
33%	P16	3	3	5	5	5	5	6	5
33%	P17	1	6	5	6	6	7	7	7
33%	P18	3	6	3	3	5	5	5	5
33%	P19	2	2	3	4	4	4	4	5
33%	P20	2	3	3	2	4	5	7	6
66%	P21	1	5	6	7	7	7	7	7
66%	P22	5	6	6	6	7	7	7	7
66%	P23	2	6	3	6	5	3	5	6
66%	P24	4	3	5	6	6	6	7	7
66%	P25	4	7	7	7	7	7	7	7
66%	P26	2	2	4	5	6	6	7	7
66%	P27	2	4	4	5	6	6	6	6
66%	P28	1	5	5	6	6	6	6	6
66%	P29	3	7	7	7	7	7	7	7
66%	P30	1	5	5	6	6	6	7	7
100%	P31	2	5	7	7	7	7	7	6
100%	P32	2	3	3	4	5	5	7	5
100%	P33	1	7	7	7	7	7	7	7
100%	P34	2	5	5	6	5	5	5	5
100%	P35	7	7	7	7	7	7	7	7
100%	P36	1	6	7	7	7	7	7	7
100%	P37	5	6	6	6	6	6	6	6
100%	P38	7	7	7	7	7	7	7	7
100%	P39	6	7	6	7	7	6	7	7
100%	P40	4	5	6	7	7	7	7	7

Table 17: Participant results for Feeling of Hindrance per condition

		Feeling of Hindrance							
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
0%	P1	4	2	1	1	1	1	1	1
0%	P2	6	2	1	2	2	2	2	2
0%	P3	1	3	1	7	1	1	1	1
0%	P4	4	5	1	2	4	2	3	5
0%	P5	3	4	3	7	5	5	3	4
0%	P6	1	1	1	1	1	1	1	1
0%	P7	7	6	4	4	4	4	4	1
0%	P8	4	4	4	2	2	2	2	2
0%	P9	4	4	5	6	5	4	6	7
0%	P10	2	1	1	1	1	1	1	1
33%	P11	1	6	5	6	6	6	6	6
33%	P12	3	2	2	2	3	4	4	3
33%	P13	4	4	4	4	4	4	4	4
33%	P14	4	4	4	2	3	3	5	6
33%	P15	6	5	3	3	2	2	5	3
33%	P16	2	2	4	5	5	5	5	5
33%	P17	4	4	4	4	5	4	5	5
33%	P18	2	2	3	5	6	6	6	7
33%	P19	3	3	4	3	3	3	3	5
33%	P20	2	2	2	2	3	3	5	7
66%	P21	1	5	7	7	7	7	7	7
66%	P22	5	2	2	1	1	2	2	1
66%	P23	2	6	3	4	5	4	6	6
66%	P24	3	3	5	6	6	6	7	7
66%	P25	4	7	7	4	4	4	4	4
66%	P26	2	3	3	5	5	5	6	6
66%	P27	2	3	3	5	5	5	6	7
66%	P28	1	5	5	7	6	6	6	6
66%	P29	2	7	7	7	7	7	7	7
66%	P30	1	4	5	3	5	5	7	7
100%	P31	1	6	7	7	7	7	7	7
100%	P32	2	5	4	4	7	7	7	2
100%	P33	7	7	7	7	7	7	7	7
100%	P34	1	6	4	5	6	5	6	6
100%	P35	7	7	7	7	7	7	7	7
100%	P36	1	5	6	7	7	7	7	7
100%	P37	6	6	7	6	6	6	6	6
100%	P38	6	7	7	7	7	7	7	7
100%	P39	6	7	6	7	7	6	6	7
100%	P40	4	5	6	7	7	7	7	7

Table 18: Participant results for Engagement per condition

		Engagement						
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
NoInf	P1	4	5	4	1	1	1	1
NoInf	P2	4	4	5	4	4	4	3
NoInf	P3	5	5	5	5	5	5	4
NoInf	P4	6	6	6	6	4	3	2
NoInf	P5	5	5	4	4	4	3	3
NoInf	P6	5	5	6	5	4	3	3
NoInf	P7	6	6	5	3	2	1	1
NoInf	P8	2	1	1	1	1	1	1
NoInf	P9	5	6	6	6	5	4	3
NoInf	P10	6	5	3	3	2	2	2
AltFeed	P11	3	1	3	5	3	2	2
AltFeed	P12	5	3	2	3	3	2	3
AltFeed	P13	5	5	6	5	4	4	3
AltFeed	P14	6	6	7	7	7	7	7
AltFeed	P15	6	6	4	3	2	4	4
AltFeed	P16	3	2	4	2	1	1	1
AltFeed	P17	6	6	7	7	7	7	7
AltFeed	P18	5	6	6	6	5	7	6
AltFeed	P19	1	2	3	4	4	5	5
AltFeed	P20	3	2	2	2	3	2	2
AltInf	P21	7	6	6	6	6	6	6
AltInf	P22	6	6	6	6	6	6	6
AltInf	P23	6	4	4	5	4	3	3
AltInf	P24	4	6	5	5	4	5	4
AltInf	P25	7	7	7	7	7	7	7
AltInf	P26	4	5	5	5	6	5	6
AltInf	P27	5	6	5	2	5	2	1
AltInf	P28	4	5	5	4	4	3	4
AltInf	P29	5	4	6	6	6	6	6
AltInf	P30	3	4	3	4	3	3	3
NoFeed	P31	5	5	3	4	3	2	3
NoFeed	P32	5	5	4	4	3	2	2
NoFeed	P33	5	5	6	6	6	4	3
NoFeed	P34	6	6	6	6	5	5	4
NoFeed	P35	4	5	5	3	3	3	3
NoFeed	P36	5	5	5	5	3	3	4
NoFeed	P37	4	5	2	1	1	1	1
NoFeed	P38	5	5	5	5	5	5	5
NoFeed	P39	6	6	6	6	6	6	6
NoFeed	P40	4	4	3	3	3	3	2

Table 19: Participant results for Annoyance at Forestallment per condition

		Annoyance at Forestallment						
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
NoInf	P1	2	4	5	5	4	4	4
NoInf	P2	2	3	3	2	2	3	3
NoInf	P3	2	4	2	1	1	1	1
NoInf	P4	2	2	1	1	1	2	2
NoInf	P5	5	4	5	4	4	4	4
NoInf	P6	6	4	3	3	2	3	2
NoInf	P7	1	5	5	5	4	4	5
NoInf	P8	1	7	6	4	6	4	4
NoInf	P9	1	3	2	2	2	1	1
NoInf	P10	6	7	6	7	7	7	6
AltFeed	P11	2	2	1	1	1	1	1
AltFeed	P12	5	5	6	7	4	4	5
AltFeed	P13	2	2	2	1	1	1	1
AltFeed	P14	1	1	1	1	1	1	1
AltFeed	P15	4	2	5	5	4	4	6
AltFeed	P16	5	4	3	2	2	2	1
AltFeed	P17	1	1	1	1	1	1	1
AltFeed	P18	5	4	2	1	1	1	2
AltFeed	P19	5	1	6	3	6	5	3
AltFeed	P20	6	5	6	6	5	5	4
AltInf	P21	3	3	3	3	3	2	3
AltInf	P22	1	1	2	3	2	1	1
AltInf	P23	2	5	3	4	3	3	3
AltInf	P24	6	6	7	4	5	5	5
AltInf	P25	2	4	3	2	1	1	1
AltInf	P26	2	3	4	3	4	2	2
AltInf	P27	5	6	3	2	1	1	1
AltInf	P28	3	3	4	3	4	4	5
AltInf	P29	6	5	4	4	3	4	3
AltInf	P30	5	4	4	4	4	3	4
NoFeed	P31	4	4	3	4	3	2	5
NoFeed	P32	1	1	1	1	1	1	1
NoFeed	P33	2	1	1	1	1	2	1
NoFeed	P34	2	2	2	2	2	2	1
NoFeed	P35	5	1	2	2	2	1	1
NoFeed	P36	2	2	2	2	2	2	3
NoFeed	P37	3	4	1	1	1	1	1
NoFeed	P38	2	1	1	1	1	1	1
NoFeed	P39	3	2	2	1	1	1	1
NoFeed	P40	1	1	4	1	4	5	5

Table 20: Participant results for Feeling of Hindrance per condition

		Feeling of Hindrance						
Cond	**Participant**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
NoInf	P1	1	2	2	1	1	1	1
NoInf	P2	2	3	2	2	2	2	2
NoInf	P3	1	3	2	1	1	1	1
NoInf	P4	3	2	1	1	1	1	1
NoInf	P5	1	1	1	1	1	1	1
NoInf	P6	3	3	2	3	2	3	5
NoInf	P7	1	4	6	4	3	4	3
NoInf	P8	1	7	3	4	3	3	3
NoInf	P9	1	3	1	1	1	1	1
NoInf	P10	3	4	4	4	1	1	1
AltFeed	P11	1	1	1	1	1	3	1
AltFeed	P12	6	6	6	6	6	6	5
AltFeed	P13	1	1	1	1	1	1	1
AltFeed	P14	1	1	1	1	1	1	1
AltFeed	P15	1	5	5	6	6	6	6
AltFeed	P16	6	3	3	2	2	2	2
AltFeed	P17	1	1	1	1	1	1	1
AltFeed	P18	5	3	2	1	1	1	1
AltFeed	P19	6	6	5	2	1	1	2
AltFeed	P20	5	6	6	6	6	6	6
AltInf	P21	1	1	1	1	1	1	1
AltInf	P22	1	1	3	3	2	1	1
AltInf	P23	1	5	3	4	2	2	2
AltInf	P24	1	5	4	3	4	4	4
AltInf	P25	2	4	3	2	1	1	1
AltInf	P26	2	4	2	4	3	4	2
AltInf	P27	2	6	3	2	1	1	1
AltInf	P28	3	4	4	5	5	5	5
AltInf	P29	6	2	1	3	2	2	2
AltInf	P30	4	5	5	4	5	4	3
NoFeed	P31	4	3	3	3	3	5	6
NoFeed	P32	1	1	1	1	1	1	1
NoFeed	P33	1	1	1	1	1	2	1
NoFeed	P34	1	1	1	1	1	1	1
NoFeed	P35	2	1	1	1	1	1	1
NoFeed	P36	1	4	6	5	5	6	6
NoFeed	P37	1	1	1	1	1	1	1
NoFeed	P38	1	1	1	1	1	1	1
NoFeed	P39	3	2	2	2	2	2	2
NoFeed	P40	2	2	2	1	1	1	1